

AGRICULTURAL ENGINEERING

AUGUST • 1951

Agricultural Engineers Advance Their Professional Standing *Fred C. Fenton*

Application of the Multiple-Use Drill in Virginia *J. N. Jones, J. H. Lillard, R. C. Hines, Jr.*

Use of Radiant Energy for Corn Borer Control *H. H. Beaty, J. H. Lilly, D. L. Calderwood*

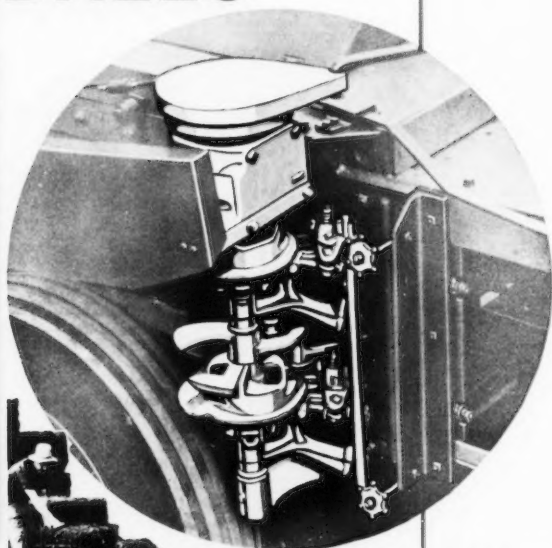
Method for Evaluating Farm Tractor Transmissions *J. Arthur Weber*

Subsoil Conditioning on Claypans for Water Transmissions *Dwight D. Smith*



THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

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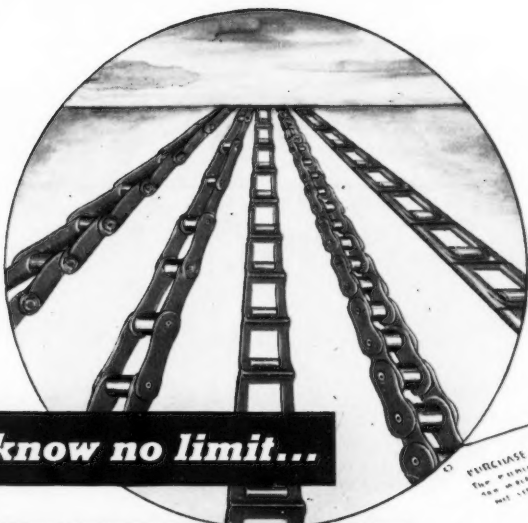
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PUMPS**

Why You Will See So Many OBERDORFER Pumps in the Years to Come...

The national Production Authority in Washington, after a very extensive examination, granted Oberdorfer permission to use every pound of copper-based alloys we requested for the manufacture of Oberdorfer Bronze Agricultural Spraying Pumps for the year 1951.

A powerful and considerable group of responsible men in the U.S.D.A., thruout the United States and in Washington personally provided the necessary records substantiating our claim of *unusual necessity* in order to make available to American Farmers the tens of thousands of Oberdorfer bronze gear pumps which they considered of vital importance to top farm production.

The additional hundreds of thousands of pounds of critically short copper alloys were allocated to Oberdorfer since the U.S.D.A., the N.P.A. and the C.M.P. were convinced crop and animal spraying by means of low pressure bronze gear pumps for the control of insects and weeds to be in the National interest.

The Oberdorfer bronze gear pump has been the world's standard since 1896. It is reasonable to expect that our experience would direct us to take care of the hundreds of thousands of farmers using our spray pumps as well as the millions who need to use them.

Write Dept. AE 518, Agricultural Pump Div., Oberdorfer Foundries, Inc., Syracuse, New York.

BE SAFE—Buy Spray Rigs Equipped with OBERDORFER Pumps
BE SURE—OBERDORFER has the Materials for Manufacturing
BE WISE—As Usual, OBERDORFER Prices Remain Below the Market

Shown above is a typical Oberdorfer cotton spray pump, #450C, driven from tractor P. T. O.
List Price \$17.00 F.O.B. Syracuse

The Name OBERDORFER is Cast on Each of the 150 Types
and Styles of Oberdorfer Bronze Spray Pumps.

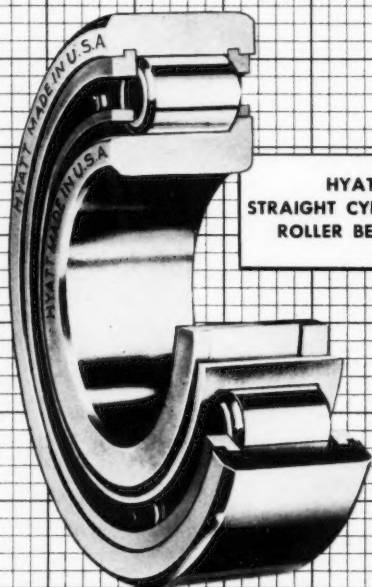
Preferred for their precision

Hyatt Hy-Load Roller Bearings are straight cylindrical bearings available in a wide range of types and sizes and with a number of different snap ring, separator, and race flange arrangements to meet a variety of application requirements.

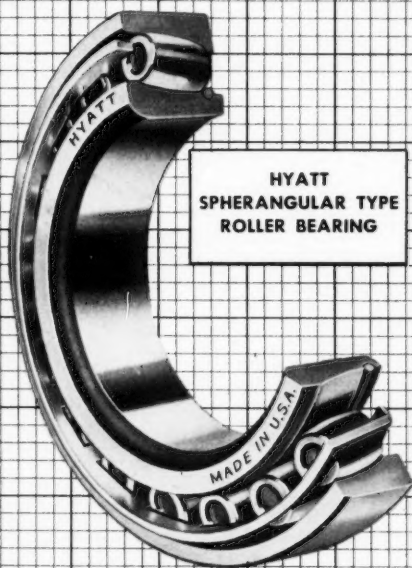
Hyatt Spherangular Roller Bearings are self-aligning angular contact bearings designed to take both radial and thrust loads. They provide ideal distribution of load on rollers under conditions of misalignment or shaft deflection.

The correctness of Hyatt design has been proven by the performance of the millions of precision-manufactured Hyatts operating year after year in tractors, combines, pickers, drills, sprayers, mowers, balers, spreaders, trucks, etc. . . justifying the equipment builder's preference for these dependable bearings and the dealer's confidence in selling "Hyatt-equipped" machines.

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HYATT ROLLER BEARINGS



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are first choice of implement builders

Some implements, like this versatile forage harvester, get a lot of action from Spring right through to Fall. And action in the field means wear.

Thus, to give the farmer the performance he expects, rugged strength must be matched with real wear-resistance by every vital moving part.

Building universal joints with these qualities has been the tradition of Blood Brothers for over a generation. And that tradition—plus prompt, willing cooperation with implement builders—has made Blood Brothers Universal Joints first choice for agricultural equipment. It's the reason why...

FOR FARM IMPLEMENTS, MORE BLOOD BROTHERS UNIVERSAL JOINTS ARE USED THAN ALL OTHER MAKES COMBINED

THESE FORAGE HARVESTERS ARE BLOOD BROTHERS EQUIPPED:

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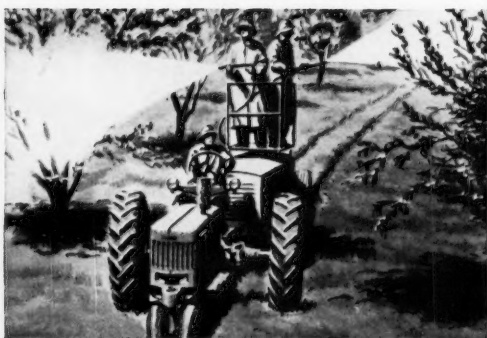


BLOOD BROTHERS machine co. ALLEGAN, MICHIGAN

Agricultural Universal Joints

Division of Standard Steel Spring Company

Chicago Office: Great Lakes Spring Division, 7035 West 65th Street



Each designed for the job to be done

Control of insects, weeds and bacteria is important to top production of crops. And manufacturers know that proper control takes sprayers and dusters of different types — depending on the job to be done.

It's the same way with Armco Special-Purpose Steels. Each one has been developed for a particular use. In the premium line of spraying equipment, Armco Stainless Steels give the manufacturer's product full protection against severe corrosion.

In the standard line of sprayers and dusters you'll find Armco ZINCGRIP, the steel with the tight-gripping, non-peeling zinc coating. Many makers of steel farm equipment prefer Armco ZINCGRIP for hog feeders, stock tanks and other things, too — its completely protective skin is more resistant to rusting. And when equipment is to be painted, Armco ZINCGRIP, Bonderized at the mill, does a superior job of taking and holding paint.

These are only a few of the extra-quality Armco Steels that help make modern farming more profitable. The famous Armco trademark stands for special-purpose metals *designed for the job* — metals that give the farmer longer service at lower cost in the products he buys.

Spraying boosts corn yields as much as 55%

Recent comparisons made by farmers on 56 farms in 26 Iowa counties showed that corn when sprayed or dusted yielded 3 to 34 bushels more per acre than untreated check strips in the same fields. At today's corn prices, this is an added income for the farmer of from \$5.40 to \$61.20 per acre — a worthwhile dividend.

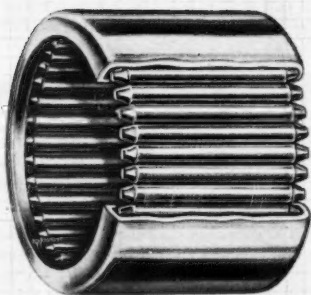
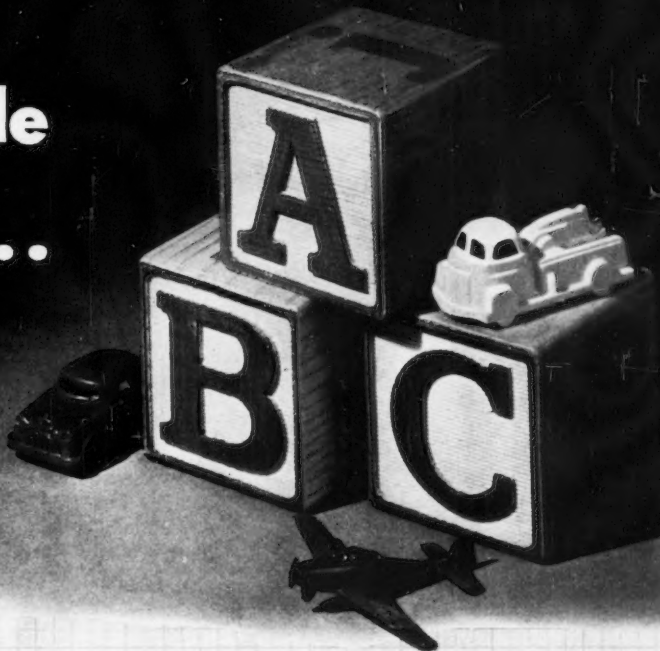
MORE SCRAP FOR MORE STEEL More steel scrap is needed for top steel production. The new furnaces the steel industry is building cannot be operated at capacity with the present scrap supply. To help the nation — and yourself — sell your steel scrap now!

ARMCO STEEL CORPORATION

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THE ARMCO INTERNATIONAL CORPORATION, WORLD-WIDE



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as ...



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- C. Simplify assembly. A fast arbor press operation seats the bearing by press fit... no spacers or retainers are needed to hold Needle Bearings in position.

Torrington Needle Bearings may well be the answer to your design and production problems. Our engineers will be glad to help.

THE TORRINGTON COMPANY

Torrington, Conn.

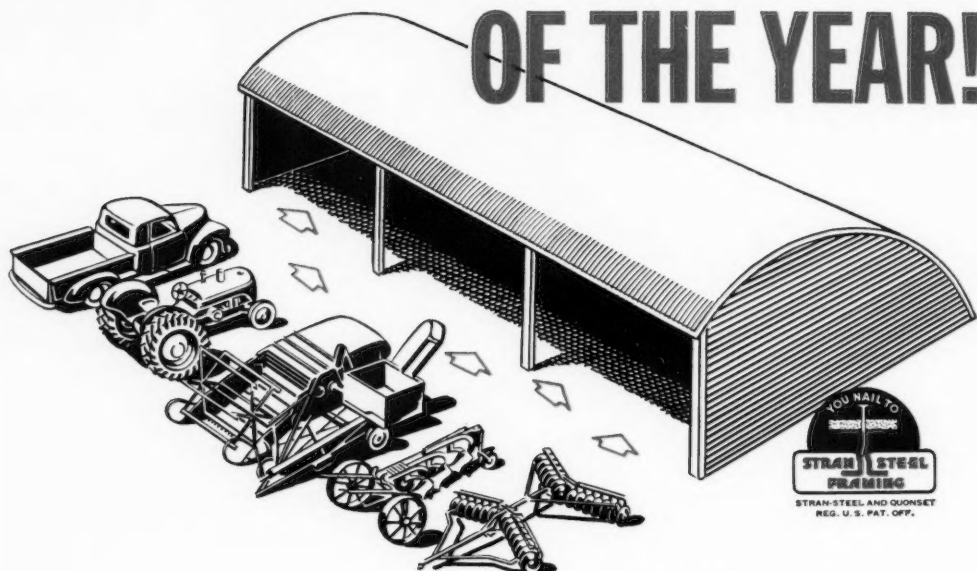
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TORRINGTON NEEDLE BEARINGS

NEEDLE • SPHERICAL ROLLER • TAPERED ROLLER • STRAIGHT ROLLER • BALL • NEEDLE ROLLERS

THE FARM BUILDING BUY OF THE YEAR!



STRAN-STEEL QUONSET 24 SPECIAL

- Perfect Shelter for Equipment or Livestock
- Easy to Buy, Erect and Maintain

This great farm building can work for you in many ways. Use it as a loafing barn for cattle—for storage of all sorts—to protect valuable trucks or farm implements. It's a real production tool.

The Quonset 24 Special is available in any length you need, in sections of 12'. Its minimum size is big enough to shelter a truck, tractor, small combine, cultivator plow and disc harrow—all at one time. No interior pillars or posts to interfere. It can be erected on raised foundations to accommodate extra-tall machinery.

For an all-round utility building that gives you year-round service, plan on adding a Quonset 24 Special to your farm this year. Get the facts from your nearby Quonset dealer right away.

QUONSETS GIVE YOU EXTRA ADVANTAGES

Quonsets are made of N-A-X HIGH-TENSILE steel, patented and produced by Great Lakes Steel Corporation. The use of this stronger, tougher steel permits simplified construction that saves you money, yet provides a structure of tremendous strength and durability. Quonsets are wind-resistant, non-combustible, rot-proof . . . completely permanent.

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A Revolutionary Metallurgical Development

DUCTILE IRON is a cast ferrous product which combines the *process advantages* of cast iron with many of the *product advantages* of cast steel.

No longer in the pilot-plant stage, this new material is now produced and sold on the basis of specifications. Not only are its individual properties exceptional, but no other com-

mon engineering material provides such a combination of excellent castability and fluidity, with high strength, toughness, wear resistance, and machinability.

Actually, "ductile iron" denotes not a *single* product, but rather a family of ferrous materials characterized by graphite in the form of spheroids...

a form controlled, in a broad sense, by small amounts of magnesium. Presence of spheroidal rather than flake graphite gives this new product a ductility that is unique among gray cast irons.

Four important types of ductile iron now being produced commercially are tabulated below.

REPRESENTATIVE MECHANICAL PROPERTIES OF COMMERCIAL HEATS OF DUCTILE IRON

Grade	Tensile strength, psi	Yield strength, psi	Elongation per cent	BHN	Usual condition
A 90-65-02	95/105000	70/75000	2.5/5.5	225/265	As-cast
B 80-60-05	85/95000	65/70000	5.5/10.0	195/225	As-cast
C 60-45-15	65/75000	50/60000	17.0/23.0	140/180	Annealed
D 80-60-00	85/95000	65/75000	1.0/3.0	230/290	As-cast

A Pearlitic in structure. Provides good mechanical wear resistance.

B Pearlitic-ferritic in structure. Provides strength and toughness combined.

C A fully ferritic structure usually obtained by short anneal of either (A) or (B). Provides optimum machinability and maximum toughness.

D Higher phosphorous content than preceding grades, also higher manganese. Provides high strength and stiffness, but only moderate impact strength.

SOME UNIQUE PROPERTIES OF DUCTILE IRON

1. Its elastic modulus, about 25,000,000 psi, is virtually unaffected by composition or thickness...
2. It can provide a chilled, carbide, abrasion-resistant surface supported by a tough ductile core. No other single material can combine these properties... its only counterpart being a tough material coated with a hard welded overlay.
3. As-cast ductile iron of 93,000 psi tensile strength has the same machinability rating as gray iron with a strength of 45,000 psi.
4. Annealed ductile iron can be machined at a rate 2 to 3 times that of good quality gray iron.
5. It can be satisfactorily welded.

APPLICATIONS

Automotive, agricultural implement, railroad and allied industries apply ductile iron, as-cast and heat treated, in components too numerous to detail.

Machinery, machine tools, crankshafts, pumps, compressors, valves and heavy industrial equipment such as rolls and rolling mill housings, utilize its high strength and rigidity.

In scores of engine, furnace and other parts serving at elevated temperatures, it provides oxidation and growth resistance heretofore unavailable in high carbon castings.

Other applications include paper, textile and electrical machinery, marine equipment, and pipe.

AVAILABILITY

Send us details of your prospective uses, so that we may offer a list of sources from some 100 authorized foundries now producing ductile cast iron under patent licenses. Request a list of available publications on ductile iron... mail the coupon now.



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Dept. A.E., 67 Wall Street
New York 5, N. Y.

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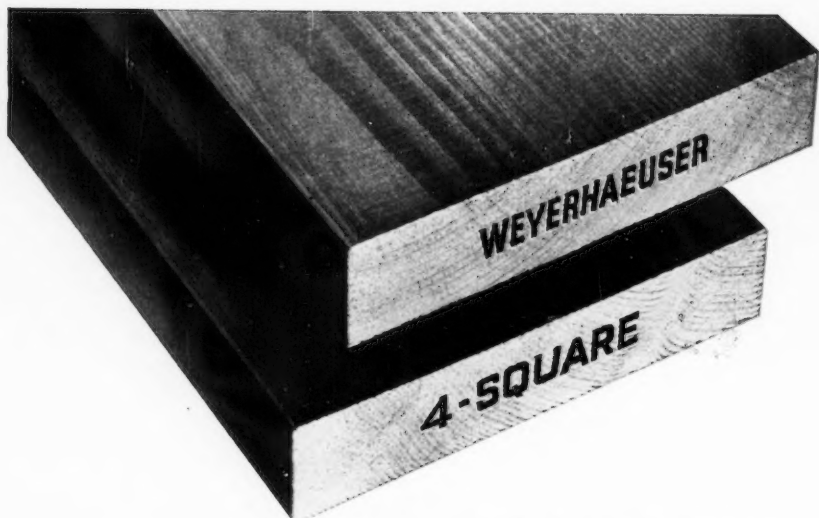
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THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.



THIS BRAND NAME ON LUMBER MEANS . . .





Certified superseedlings get a strong, sturdy start in tree nursery before being transplanted.



Intensive research to make tree crops better is never-ending task with Weyerhaeuser forestry experts.



Side by side, growth and death. Planned, scientific tree farming helps to prevent this needless waste.

Scientific Harvesting of Fine Timber Stands

To the men of Weyerhaeuser, it is necessary to see BOTH the forest and the trees as part of the job of producing good quality lumber on a continuing basis.

Progressive forest management, as practiced by Weyerhaeuser, is based on a policy of permanent mill operations within prescribed timber areas. In this program, the timber harvest for each year is prudently scheduled.

There are two methods of harvesting mature timber . . . block logging and selective logging. Block logging is clear logging of mature trees. Islands of seed trees are left to re-seed the cutover blocks. This returns the land to productive utility with trees of uniform age.

In selective logging, certain trees are removed, leaving room for the development of young timber. The type of logging pursued depends upon the type and location of the forests involved. As a further means of re-stocking the forest lands, manual and mechanical planting of seedlings are employed where natural re-seeding does not take place.

Weyerhaeuser forest and mill practices have been constantly improved and modernized, always with the view

of increasing the forest yield, and obtaining more usable products out of every tree.

A continuous supply of better quality lumber for present and future needs is the program behind every piece of lumber bearing the brand name "Weyerhaeuser 4-Square".

One of a series of advertisements defining the important factors contributing to the production of good lumber.

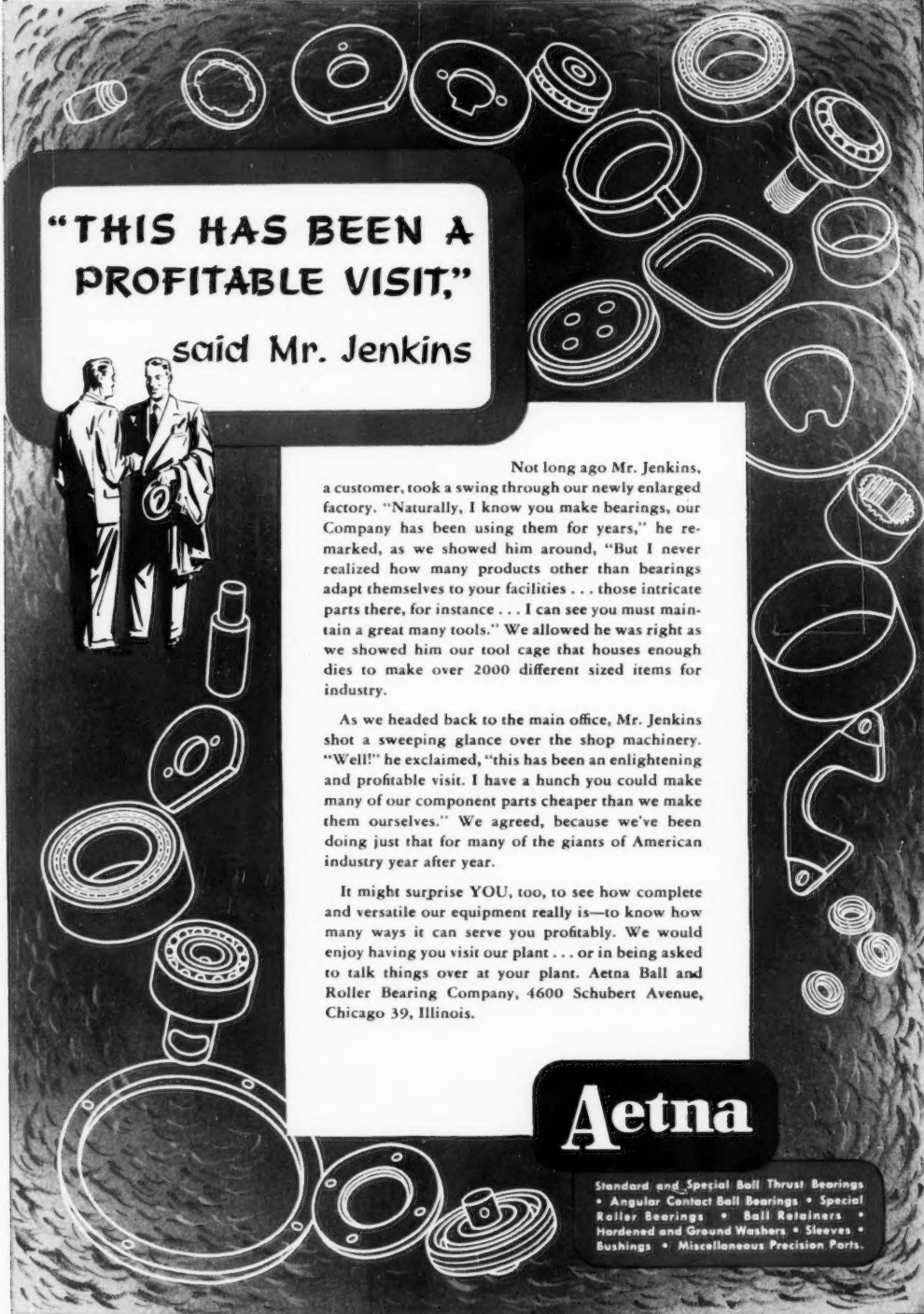


The Springfield, Oregon Mill

At mills located on the West Coast and Inland Empire, Weyerhaeuser 4-Square Lumber is produced in a wide range of products from Douglas Fir, Idaho White Pine, Ponderosa Pine, West Coast Hemlock, Western Red Cedar & related species.

Weyerhaeuser 4-Square Lumber and Services

WEYERHAEUSER SALES COMPANY • ST. PAUL 1, MINNESOTA



**"THIS HAS BEEN A
PROFITABLE VISIT,"**

said Mr. Jenkins

Not long ago Mr. Jenkins, a customer, took a swing through our newly enlarged factory. "Naturally, I know you make bearings, our Company has been using them for years," he remarked, as we showed him around, "But I never realized how many products other than bearings adapt themselves to your facilities . . . those intricate parts there, for instance . . . I can see you must maintain a great many tools." We allowed he was right as we showed him our tool cage that houses enough dies to make over 2000 different sized items for industry.

As we headed back to the main office, Mr. Jenkins shot a sweeping glance over the shop machinery. "Well!" he exclaimed, "this has been an enlightening and profitable visit. I have a hunch you could make many of our component parts cheaper than we make them ourselves." We agreed, because we've been doing just that for many of the giants of American industry year after year.

It might surprise YOU, too, to see how complete and versatile our equipment really is—to know how many ways it can serve you profitably. We would enjoy having you visit our plant . . . or in being asked to talk things over at your plant. Aetna Ball and Roller Bearing Company, 4600 Schubert Avenue, Chicago 39, Illinois.

Aetna

Standard and Special Ball Thrust Bearings
• Angular Contact Ball Bearings • Special
Roller Bearings • Ball Retainers •
Hardened and Ground Washers • Sleeves •
Bushings • Miscellaneous Precision Parts.

EDITORIAL

Professional Prosperity

AGRICULTURAL engineers as a group are enjoying an unprecedented period of professional prosperity.

We are sharing the general active demand for the services of all branches of engineering and applied science. Recognition of the special field of agricultural engineering has spread to additional leaders in farming, processing, manufacturing, government, and education, both in the United States and in other parts of the world. Most of our agricultural people have tasted some of the advantages of modern farming and are hungry for more of those advantages. Industry and government are being pushed to provide more and better results in terms of better living. Defense problems add to the pressure for progress. An impatient generation wants to live better today.

Modern farm equipment, homes, electrification, methods of soil and water control, automobiles, radio, and television suggest further benefits from engineering. People have learned to expect progress in engineering. Engineers are riding the crest of a wave of professional prosperity. There are indications, however, that this is not an automatic, permanent, self-sustaining, or stable condition of equilibrium.

History has shown that few individuals or groups are able to stand prosperity for very long. Nevertheless, it is human nature to welcome the opportunity to try. We prefer the problems of prosperity to those of adversity.

Of all mortals, engineers may be among the best qualified to survive the trials, temptations, and general debilitating effects of prosperity.

A natural selection of young men potentially qualified to make intelligent use of some measure of prosperity results from their voluntary choice of a rigorous training.

Their training in engineering contributes to the development of an appreciation of higher values, reducing any temptation they may have to become "prodigal sons."

Engineering training tends to develop an extraordinary capacity for objective outlook, the ability in a man to see himself, his associates, and his total environment in some perspective other than that of his instinctive desires. It tends to develop interest in abilities, accomplishments, and knowledge beyond their capacity to contribute to earning power. It helps to develop a sense of responsibility; the recognition and willing acceptance of an obligation to serve.

It provides incentives to work beyond the requirements of self-preservation and security; incentives more realistic than the illusion of happiness to be gained by material possessions and self-indulgence.

What then are the problems of professional prosperity to be recognized and faced by engineers?

We should recognize the probability that many of us may have not yet learned well enough the above lessons of engineering training and experience to be above the temptations of prosperity. Prosperity, as an influence toward stagnation, misdirection, and decay, is not to be underestimated.

Under the pressure of continued high demand for engineers, there may be a temptation to reduce their training requirements. Faced with urgent work assignments, individual engineers are apt to neglect their continued individual studies, broadening contacts, and other means to professional development. The engineering profession, and agricultural engineers as a group, might well counter these pressures with positive encouragement toward continuing broad development for engineering leadership. This is no time to narrow and lower engineering qualifications for service.

There is a possibility of the profession becoming unbalanced in the direction of having too many of its members engaged in refining known workable applications of physical principles, and too few employed in the pioneering work of exploring new approaches to physical problems. One Rudolph Diesel developed and demonstrated a new type of internal-combustion engine, and since then thousands of engineers

have been employed in bringing the Diesel engine up to its present high state of refinement. This work of refining basic applications is important, but in any one specific case it must ultimately reach a point of diminishing returns. It will be to the interest of the engineering profession to see that enough of its potential Rudolph Diesels are employed primarily in developing new approaches for refinement by other engineers.

There is a danger of being misunderstood and alternately over-glamorized and condemned by an ill-informed, emotional, impatient, critical public. The public is interested in engineering primarily for what it can give them, and is capable of exerting strong influence on the freedom of opportunity for engineers to work effectively. To minimize this danger, engineers need to continually remind the public as to the nature of engineering. Engineers deal with facts. They can discover new information concerning existing natural law, principles, conditions, and materials. They can develop new and useful applications of both new and old established knowledge. They are not magicians and they cannot modify, nullify, repeal, violate, or ignore natural law to satisfy either the whims or the sound and real desires of the public for certain apparently desirable results. Relations between engineers and the public will hold to a satisfactory basis to the extent that the public can be made to appreciate these simple realities of engineering.

Other hazards of prosperity might be mentioned. These may be enough, however, to emphasize that while we are riding high is a time to be particularly on guard against a fall. The acceptance and prosperity of engineers has developed on a foundation of meritorious service, and can be maintained only on the same basis. There are further major opportunities for service in agricultural engineering to be explored and developed. We cannot afford to rest on our laurels or to start indulging in excessive use of airfoam cushions. We can stand a measure of professional prosperity if we can see beyond it to new challenges in nature as we know it, as compelling and demanding as those against which earlier pioneers proved their mettle.

Tomorrow's Problems

THE way things are going, it looks as if there will be a bright future for the engineer who can show the world how to put atoms back together again.

Teaching Democracy

AT INTERVALS as they have come to our attention we have mentioned here interesting contributions by ASAE members and others to improvement in the understanding and operation of democracy.

Another ASAE member who has recently developed an interesting idea along this line is F. W. Moffett, Jr.

His proposal deserves more space than we can give it. In brief, he proposes that our schools teach the practice as well as the theory of democracy. He suggests definite regular classes in the subject beginning at the third or fourth grade of grammar school and continuing through high school and college. These classes would require study, discussion, and writing on current, local or broader public questions appropriate to the educational level and interests of the class.

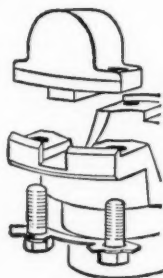
This could help greatly to stimulate in the students, and their parents as well, the active personal interest and habit of participation in representative government which is the right and responsibility of every citizen. It could do a lot to make our governments—local, state, and national—more truly representative of a better-informed public opinion. It could help to provide a more promising environment in which to live and work, for agricultural engineers and people in all walks of life.

We commend Mr. Moffett for emphasizing a significant point, the importance of learning the practice as well as the theory of democracy.

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Agricultural Engineering in a Period of Confusion

By Fred C. Fenton

FELLOW A.S.A.E.

IT HAS been the custom for the president of the ASAE at the annual meeting to make what is called the president's annual address. Many presidents have dwelt on our accomplishments, on the nature of the profession, and on the good work we are doing. This has been natural in a young profession which is struggling for recognition. Since we have arrived at a point where we are recognized and there is now little doubt about our position, there is little need for me to discuss or defend agricultural engineering as a profession. It is rather for me to recognize the steps we have advanced in the past year and to survey the prospects and challenges which my limited vision sees ahead of us.

During the past year, the steady progress of earlier years has gained momentum and made this year one of the best years in the history of our Society. And this at a time of perhaps more dissatisfaction and of more confusion in our national life than in any other year in which the Society has been in existence.

During the past year the Society has made substantial progress in many fields.

First off, we have improved our professional standing. Several years ago the Engineers' Council for Professional Development (ECPD) challenged us to show that our training was truly engineering in character. After a period of confusion within our own councils, we met the challenge of ECPD, improved our textbooks and the content and organization of our courses. We also were granted a representative on the examining committees which insured that our problems were given a sympathetic hearing. A total of sixteen curriculums have been accredited by this national accrediting agency. This means that our graduates are accepted as engineers and are eligible for registration as professional engineers in many of the states. One of our unfinished jobs is to complete and develop this professional standing in all the states.

For many years a second great need of agricultural engineering has been to increase our membership, that is, to increase the number of agricultural engineers at work, so that we can more fully occupy our rightful field and accomplish the tasks which need to be done. During the past year we have made progress in increasing the number of agricultural engineers. The enrollment of students which increased in the period following World War II gave us, for the first time, a fairly good crop of agricultural engineering students. This has resulted in a larger increase in the membership of the Society. There has been a substantial increase in our ASAE membership—now totaling more than 3400—one of the most desirable developments of recent years.

A natural result of improved professional standing and of increased membership is the greater recognition which our

field has achieved. More people now talk about agricultural engineering; more students are advised to take this curriculum; more employment opportunities are offered to the graduates. The development of this recognition is natural because our fields of work have been increasing in importance. Our work

in power and machinery and in rural electrification will help solve the problems of the present emergency as labor is drafted from the farms for the armed forces and arms industries. Progress in farm structures design is proving the value of regional cooperative planning and effort.

The results of these several fields of effort are partly reported in our official journal, *Agricultural Engineering*, which constitutes the main literature of agricultural engineering. We must work to improve the technical competence of the Journal and to keep it on the high plane to which it has been brought.

There has also been an increase in the number of geographical sections of our Society, which bring all members within reach of possible meetings and which add greatly to mutual interest and sharing in our work.

Thus progress and growth in our Society has been steady, and we should meet future problems with greater assurance. Signs show that as a profession we have reached a certain degree of maturity. One sign is that a committee headed by Dr. J. B. Davidson, our first

ASAE president, is writing a history of the first fifty years of the Society. This seems to me a most appropriate undertaking. It will be valuable for us and for those to come to have the early history of the Society recorded by those most responsible for its formation and growth.

A second sign of our maturity is that competition is growing. Other groups such as the A.S.M.E. seek to enter the farm management field, and the agronomists would take over the soil conservation work. Of course, there is work for all, but we want jobs to be done by those best qualified.

Another sign of our maturity, perhaps the greatest recognition of our responsible adulthood, is seen in the problems we are asked to help solve. Many are problems within the United States. Some are problems beyond the shores of America, and are part of America's inevitable if somewhat unwilling internationalism.

The high material standards by which we Americans live and the action by which we gained our independence have been an inspiration to the subject peoples of the earth, an inspiration which they are now translating into action. Many of the world's half-starved, ill-clothed and poorly housed look to America for guidance and aid in realizing their aspirations.

Although we agricultural engineers do not often state our aim in these words, still I believe we can say that a constant aim is "the more abundant life," both for those who make their living on the land and for those who use its products. The desire for an abundant life is a fundamental human aspiration, a mainspring of individual and group initiative. Within the broader concepts of the meaning of abundant life



FRED C. FENTON
President, ASAE—1950-51

Annual address of the President of the American Society of Agricultural Engineers before the 44th annual meeting of the Society at Houston, Tex., June, 1951.

The author: FRED C. FENTON, head, agricultural engineering department, Kansas State College, Manhattan.

are included the objectives of religions, arts, governments, educational systems, social agencies, labor unions. Of its more commonly held material concept, Dr. Karl T. Compton has said, "From the dawn of history up to the modern era of science, there have been only two primitive recipes for securing the materials desired for the more abundant life. One was to work hard and long in order to produce more, and the other was to take the good things of life from someone else by theft, conquest, taxation or exploitation."

Running all through history are records of taking what it wanted from others by violence, trickery, legalized strategy, or force. Even the children of Israel, emerging from their bondage in Egypt, wrested from the Canaanites their "land flowing with milk and honey". The ethics of the case did not disturb them, for were they not "the chosen people"? The Romans conquered their known world in order to exact tribute and slaves from the conquered peoples, and to exploit their mines and farms. In 1492, Europe began to seek abundance by exploitation of the newly discovered lands of America, which they took from the Indians by conquest and treaty. Two centuries later nations were robbing Africa of its ivory and gold and capturing its people for slaves. And leading to World War I and to World War II were practices of exploitation when nations considering themselves "chosen people", tried to achieve the abundant life at the expense of others.

But now modern science and engineering have developed to give mankind, for the first time in history, ways of securing more abundant life which do not consist simply in taking it away from someone else. Science really creates wealth and opportunity where they did not exist before. The new order of science, invention, and engineering makes possible a cooperative, creative effort in which everyone is the gainer and no one is the loser.

NEW DEVELOPMENTS IN THIS CENTURY

The first half of this century has brought an array of new developments which have had a tremendous influence on our well-being and on our pattern of life. The basic inventions of the following nine developments were earlier, but their practical adaptations have come in our time:

- 1 The development of power and machinery for agriculture released 85 per cent of our people from the necessity of producing food and made possible our astounding industrial development and the great increase in service occupations.
- 2 Automobiles (one for every five people) brought mobility, decentralization.
- 3 Telephones speeded up business transactions, multiplied human contacts.
- 4 and 5 Motion pictures and radio, with all their influences for good and bad.
- 6 Airplanes.
- 7 Mechanical refrigeration.
- 8 Electric light and power.
- 9 Synthetic fibers, with reduction of the gap between Judy O'Grady and the Colonel's Lady.

What will be comparable developments in the second half of the century? Will they bring peacetime utilization of atomic energy and of solar energy? Population pressures are bringing prefabricated housing. What else? Will we have widespread adoption of a successful cotton picker? You predict some more.

Since we are travelling at a more rapid rate in all activities, it seems likely that new developments will come more rapidly and in more striking character than those of the first half of the century. And it seems certain that agricultural engineers will have even more important problems to solve during the next fifty years.

Whether we as a profession will continue to advance and prosper depends upon the answer to two vital questions that now confront our country. One of these questions is inflation. The other is war. The two often travel together. How far will the present inflation run? Can it be checked or stopped without reversing the spiral and plunging our economy into a depression? As engineers we are conscious of Newton's law

of motion that for every action there is an equal and opposite reaction.

With the expanded productive capacity of wartime, the United States is likely to produce goods in excess of demand, and prices will fall. But during recent years we have applied many forms of stimuli to the buying power of people in order to maintain or increase the demand for goods. During the year 1950 several kinds of special stimuli were supplied by the federal government. First, we paid the veterans in cash about three billions in dividends on life insurance. We continued the veterans' college and in-service training programs, thereby distributing generous amounts of cash. We subsidized agriculture with cash payments for approved farm practices, under the guise of soil conservation, while we maintained prices for standard farm crops at parity prices by loan programs, crop insurance, and the purchase and storage of surplus crops.

We carried out extensive reclamation projects for irrigation and flood control.

We used large grants of federal money for the construction of public roads.

We financed the housing program, which produced 1,300,000 new dwelling units in 1950, by federal loans requiring small down payments, and we thereby created a boom in all parts of the building trade and business in general.

INFLATIONARY PRESSURE AND DELIRIUM OF PROSPERITY

All of these expenditures might have been carried without great inflationary effects or without increasing the national debt. But in the fall of 1950 a military emergency was declared, and the movement started to spend billions for war preparations and war material. All these in addition to an above-normal business activity created terrific inflationary pressure. It is not surprising that we now find ourselves in the midst of a "delirium of prosperity". The Doane Agricultural Service of St. Louis reports the greatest land boom in the history of the nation. More people want to buy farms than ever before.

This inflation must be stopped. It threatens the political, economic, and social structure of our country. The middle class is particularly hard hit. Our engineering Society is feeling it as shown in the fact that these meetings have already become too expensive for most of the members.

Shortly after the annual ASAE annual meeting in Washington a year ago, our troops entered a war in Korea. American citizens have had conflicting reactions to our part in this conflict. "It has been a period of confusion, anger, frustration, fear and suspicion." When we study this phenomenon of the past year, we may conclude that it is the climax of a long period of confusion in which we have been operating for many years. After World War I we repudiated the League of Nations and refused by this act to accept our part in world leadership. We withdrew into isolation and attempted to live our life as we had since pioneer days. World War II thrust us into a still greater world conflict, and at the end of this conflict we were confused as to what our attitudes and policies should be.

Much of the confusion of the past year comes from our not recognizing nor understanding some of the great movements and ferment in the world. Russia presents problems we have been unable to solve. We are unable even to agree among ourselves as the best way of overcoming this menace to our way of life.

Out of this confusion in our country seem to emerge two main movements. One is preparation for future war, including military aid to our friends—those others who oppose communism. The other is aid to the less fortunate peoples of the world, to help them to improve their conditions.

Many of the world's half-starved people look to America for aid in achieving a development that will improve their lot. Many so-called backward peoples have had visions of our more abundant life and are pushing to realize it, by whatever system seems to offer most hope, even by war if no other way appears. They need, and they know that they need modern methods and tools to increase their food and fiber production and distribution.

(Continued on page 419)

Application of the Multiple-Use Drill

By J. Nick Jones, Jr., J. H. Lillard, and R. C. Hines, Jr.

ASSOC. MEMBER A.S.A.E.

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AGRICULTURAL land in Virginia is located in three different and distinct geological provinces, namely, the Coastal Plain, the Piedmont, and the limestone valleys and Upland Regions. Small grain crops are grown extensively as a part of the land-use program in each of these areas.

Average rainfall varies from about 34 in per year in the northwest section to more than 50 in in the southeast and southwest areas. It is fairly evenly distributed in total amounts throughout the year, but most of the high intensity storms come during May, June, July and August. Therefore, erosion losses from small grain crops are much less severe (4)* than from those crops, such as corn and tobacco, which are tilled during the summer months.

Perhaps that is one of the reasons why tillage methods used for the production of small grain have changed so little in recent years. However, the present trend towards greater utilization of crop residues for mulches in the production of farm crops, including small grain and supplemental pastures, has resulted in rather wide-spread research to develop mulching practices which will extend the effectiveness of present conservation measures such as strip cropping, contour cultivation, pasture management, etc.

Other investigations (1, 2, 3, 6) have shown that vegetative mulches are very effective in dissipating the energy of falling raindrops and in maintaining a highly absorptive soil condition. Those studies showed also that the use of mulching practices to reduce soil and water losses presents special

problems in machinery requirements, planting and fertilization practices, and weed control.

In Virginia the machinery requirements for mulch tilling small grains have been studied jointly by the Virginia Agricultural Experiment Station and the Tennessee Valley Authority. This report summarizes results obtained with experimental models of multiple-use drills during the 1947-50 period.

The term "multiple-use drill" as used in this paper refers to a machine which performs the tillage operation, sows the seed, and applies the fertilizer in a single operation. The idea of doing the whole seedbed preparation and seeding operation in one time over the land is not new. Enterprising farmers have recognized particularly the time- and labor-saving possibilities of such a procedure. In some cases farmers have devised machines or combinations of several machines hitched in series to accomplish that end. More recently some commercial machines have been produced to do the job.

The Experimental Machines. In the Virginia studies two experimental multiple-use drills were used. Drill No. 1 consisted essentially of a conventional drill grain box suitably modified and mounted on a Ford-Ferguson tiller with seed and fertilizer tubes attached to each opener (Fig. 1). During the experiment, the machine was converted from a three-point tractor-mounted, lift type to a two-wheel trailing type with remote hydraulic control (Fig. 2). The opener shanks were of the standard spring-release type used on the Ford-Ferguson tillers. Rolling coulters with spring releases were mounted in front of each opener. Press wheels were mounted behind each opener for part of the tests. Row widths, opener types and seeding rates were adjustable to meet experimental requirements. Since the opener shanks were attached to a rigid tool bar, depth control on irregular land was unsatisfactory. Machine No. 2 was an experimental unit assembled by Deere and Company for use in these and similar studies (Fig. 3). It consisted of a standard grain-drill box mounted on a trailing-type field cultivator with seed and fertilizer tubes attached to each opener. Rolling coulters were mounted in front of the openers. Provision was made for mounting press wheels when desired. Each opener was individually swung with provisions for spring pressure adjustment for uniformity of depth con-

This paper was presented at a meeting of the Southeast Section of the American Society of Agricultural Engineers at Memphis, Tenn., February, 1951.

The authors: J. NICK JONES, JR., and J. H. LILLARD, respectively, assistant agricultural engineer and project leader, soil and water conservation research, Virginia Agricultural Experiment Station (Blacksburg), and R. C. HINES, JR., agricultural engineer, agricultural engineering branch, Tennessee Valley Authority.

ACKNOWLEDGMENT: The authors are indebted to J. W. Propst, former assistant agricultural engineer, Virginia Agricultural Experiment Station, for conducting the field work during 1947 and 1948.

*Numbers in parentheses refer to the appended references.

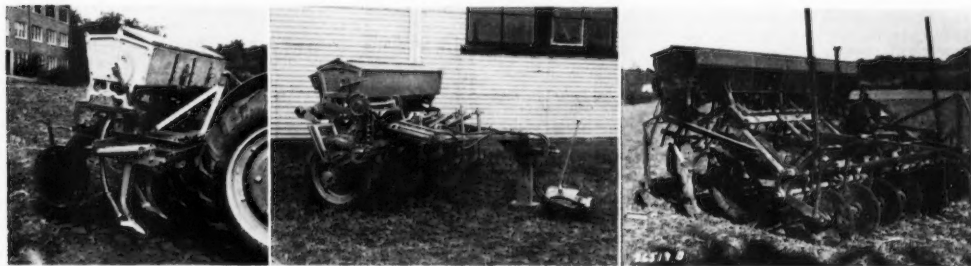


Fig. 1 (Left) First tractor-mounted experimental multiple-use drill developed by the agricultural engineering division of the Tennessee Valley Authority. The machine consisted of a conventional grain-drill box mounted on a Ford-Ferguson spring-release tiller with seed and fertilizer tubes attached to each opener. The modified feed mechanism of the three-point, tractor-mounted, lift-type machine was powered by two ground drive-wheels. Three furrow-opener spacings, 8, 12 and 15 in., were provided for on this machine and depth control was adjustable around 3 in. for seeding small grains. • Fig. 2 (Center) The modified TVA developed multiple-use drill with latest mechanical features. The two-wheel, trailing-type, hydraulic-controlled machine consists of the original Ford-Ferguson spring-release tiller with a conventional grain-drill box mounted on two carrying wheels. A chain drive from one of the carrying wheels is actuated through an automatic clutch which operates the feed mechanism when machine is in operation. An hydraulic cylinder connected to the lifting bar provides depth control adjustments together with power for raising and lowering the furrow openers. The rolling coulters that are mounted in front of each opener are provided with spring mountings. • Fig. 3 (Right) The multiple-use drill developed by engineers of Deere & Co., consisting of a standard grain-drill box mounted on a 7-ft. spring-tooth, trail-type field cultivator with seed and fertilizer tubes attached to each opener. The feed and lifting mechanisms are driven through an automatic clutching device by one of the cultivator wheels. The row spacing on this machine is fixed at 12 in., but depth control is adjustable. Rolling coulters are mounted in front of each furrow opener.

trol. Seeding and fertilizing rates were adjustable but width-of-drill row spacing was fixed at 12 in.

Experimental Tests. The initial field tests in Virginia were conducted on sites which covered different soil, topographic and climatic conditions. Results of those trials indicated that similar relative performance between the multiple-use drill and conventional seeding practices prevailed under all conditions tested. On the basis of these findings and because of the expense and other difficulties encountered in controlling and harvesting outlying areas, all test sites have been located at Blacksburg during the last two years.

The 1947 Studies. Two farms in Lee County and two in Wise County were used for field trials. Small grain seeding in lespedeza stubble included wheat, barley and oats using seven drill modifications. In the mulch treatments, 8, 10, 12 and 16-in spacings were used with chisel and winged-chisel openers on the multiple-use drill; check plots were disked and seeded with conventional grain drill. Rates of seeding and fertilization normally practiced by the farmer were followed as nearly as adjustments on the experimental drill would permit.

Yields where the multiple-use drill was used were from 25 to 50 per cent less than those on the check plots. No one of the mulch treatments was superior to the others. From a soil and water conservation standpoint, the multiple-use drill plots had a much better protective cover, but the excessive growth of weeds and some legumes was highly objectionable.

The depression in yields substantiated the findings from other mulch tillage work by this department (3,5). Several factors which tended to cause depressed yields were: (a) regrowth of weeds, perennial grasses and legumes, and (b) poor seed germinating conditions in seedbed, particularly where soil moisture conditions were unfavorable.

PRESS WHEELS AND FERTILIZATION RATES STUDIED

The 1948 Studies. To alter the possible effects of the nitrogen tie-up in the decomposing mulch and the poor seed-germinating conditions, press wheels and fertilization rates were closely studied. The John Deere multiple-use drill was used for all seedings at three different locations. Seedings were made on lespedeza and corn stubble land located at Charlotte Court House, Blacksburg, and Gate City, Virginia.

The yields obtained with the multiple-use drill on lespedeza sod were about 30 per cent lower than those by conventional practices, but on corn stubble land there was no significant difference in yields. No significant difference resulted from the use of press wheels. Good rains immediately after seeding may have eliminated any advantages that compaction might have shown. Top dressing the mulch treatments with nitrogen in the early spring increased yields at each location from 15 to 25 per cent.

At this stage of the study there appeared to be at least two applications for the mulch-seeding practice despite the depressed yields encountered: (a) It might enable the farmers to produce an additional crop of grain with a minimum of labor from land left in lespedeza, and (b) it could be used as a means of establishing a winter cover crop for supplemental pasture and turned under for a green manure crop in the spring.

The 1949 Studies. From the findings during previous years, several changes were made in the mechanical structure of the multiple-use drill No. 1. It was converted from a tractor-mounted to a trailing-type machine. The drive was shifted to one of the carrying wheels with a clutching device. The rigidly attached rolling coulters were redesigned and provided with spring mountings.

Three locations were used for the 1949 tests, making use of both lespedeza and corn stubble land. Eight mulch treatments were used against two conventional drill treatments. On the multiple-use drill plots, 8 and 12-in spacings with chisel and winged-shovel openers were used. Each spacing and furrow opener was used with and without press wheels. The fertilizer rate for all plots was 500 lb per acre of 4-12-4 or 3-12-6 fertilizer, plus top dressing in the spring with 30 lb of

nitrogen per acre. The seeding rate was kept constant at 5 pecks per acre. Wheat was seeded on all plots.

The yield data were computed to bushels per acre and a statistical analysis made using analysis of variance on these randomized block experiments. The data from all three locations were lumped together and analyzed first. From the whole experiment the analysis showed no significant difference in the ten treatments. On the basis of these results there would be no loss in yields in applying mulch tillage practices and no reason to believe any of the treatments would act differently on different soil types.

YIELDS FROM CONVENTIONAL DRILL HIGHER

The 1950 Studies. The plot layout located at Blacksburg consisted of six replicates of the same ten randomized treatments as used in 1949. Vahart wheat was seeded in corn stubble at the rate of 5 pecks per acre and fertilized at the rate of 500 lb with 4-12-4 fertilizer at seeding, with 30 lb of nitrogen top-dressing per acre applied in February. Excess moisture plus the effect of nitrogen top-dressing produced lodging of the grain which reduced the wheat yields from all plots. Analyses of results indicated that the yields from the plots seeded with the conventional drill were significantly higher than from those seeded with the multiple-use drill. One interaction effect, spacing times compaction, was also significant at the 5 per cent level. The compaction effect alone was almost significant and in every case except one, the treatments without compaction produced a higher average yield than those treatments where press wheels were employed. In most cases the yields from the mulch-seeded plots were from 20-25 per cent lower than those from the conventional seeding methods.

Three field areas were seeded with the John Deere multiple-use drill (12-in spacing) for supplemental winter pastures. A permanent blue-grass-pasture area of 4 acres was seeded to rye grass with the alfalfa, tooth opener and fertilized with 240 lb per acre of 2-12-12 fertilizer and 160 lb of ammonium nitrate per acre. Five acres in an alfalfa field were seeded to barley at the rate of 2 bu per acre with the alfalfa tooth opener and fertilized with 500 lb of 2-12-12 fertilizer per acre. The third area, consisting of alternate strips of lespedeza stubble and silage corn stubble, were divided into two lots. A mixture of barley, oats and wheat was seeded on both lots at the rate of 3 bu per acre. One lot was seeded with the multiple-use drill and the other one disked and seeded with a conventional grain drill. Both lots were fertilized alike with 100 lb per acre of ammonium nitrate and 400 lb per acre of 2-12-12 fertilizer.

These trials were of an exploratory nature intended to provide information for the design of effectively controlled supplemental pasture experiments. Adequate livestock were not available in the early part of this season for proper utilization of the herbage produced. It was observed, however, that the seeding of barley in an established alfalfa crop produced a large amount of winter grazing without significant damage to the stand or reduction in subsequent yields of alfalfa.

The small grain mixture which was seeded in the corn and lespedeza strips also produced an appreciable amount of winter pasture. Due to the fact that the multiple-use drill seedings were spaced at 12-in row widths the grain in these areas did not stool out sufficiently to give an intense coverage as obtained with the conventional drill. The animal unit days of grazing were considerably less on the mulched area. It is probable that all or most of this grazing differential was due to improper pasture management during the early part of the season. Production of the Italian rye grass seeded in the blue-grass pasture was highly disappointing. Very little additional grazing was provided. This result may have been influenced by both the density of the bluegrass sod and the unusually mild fall experienced in 1949.

DISCUSSION

Soil and water conservation effectiveness has been improved where crop residues are used as mulches. The use of mulching practices in the production of small grains has presented special machinery requirements. The multiple-use drill

seems, basically, to approach the required machine. In Virginia, small grains seeded with the multiple-use drill which prepares the seedbed and drills the seed and fertilizer in one operation, have not consistently produced yields comparable to conventional methods. In corn stubble land where surface mulch is generally thin, satisfactory yields have been produced in some seasons. In lespedeza stubble and where other perennial grasses and weeds form a heavy mulch, seeding with the multiple-use drill has produced yields from 25 to 50 per cent lower than by conventional methods. One of the factors having the most influence on reduced yields is believed to be climatic conditions. Problems of soil tilth and seed germination have been partially overcome by the use of several types of furrow openers and press wheels. Different rates and fertilization methods have been employed in an effort to reduce plant nutrient tie-up and competition from grasses and weeds for both nutrients and moisture.

The most effective row spacing has not been firmly established but appears to be from 8 to 10 in. From the standpoint of retaining a protective cover on the land, the wider spacings are desired; however, there is some indication that grain yields are adversely affected by the wider spacings particularly when row widths exceed 10 in. Likewise, the size and shape of the opener used must be a compromise between one which will give minimum disturbance to the soil and cover for good conservation and one which will produce the amount of tillage necessary for good seed germination. Both the row spacing and opener requirements appear to be so greatly affected by soil and climatic conditions that definite recommendations cannot be made at this time.

The application of the multiple-use drill in the seeding of grass and grain mixtures for supplemental winter pastures is under study. It appears that the row spacing and furrow opener combination which is most effective for small grain production will generally prove best for pasture seedings. The exception is the case where it is necessary to do a minimum of damage to the crop already on the land, such as the seeding of small grain in established alfalfa stands. In these cases a narrow opener similar to the alfalfa tooth is desirable.

The time and labor saving accomplished with the multiple-use drill are important considerations in its favor. The small grain and supplemental pasture seeding season is relatively short and comes at a time of year when other farm operations are pressing. The fact that both the tillage and seeding can be accomplished in a single operation permits more effective adaptation of the seeding program to existing weather conditions.

CONCLUSIONS

The problems of producing small grains and supplemental pastures by mulching procedures have been investigated during the past four years. The results indicate that problems of germination, vegetative regrowth, and fertilization requirements similar to those encountered in the application of mulch principles in the production of corn, are evident. All of these factors are so greatly affected by climatic conditions that consistent results with the same treatments have not been obtained throughout the experiment.

It appears that the experimental multiple-use drill used in these tests embodies the essential mechanical features necessary to minimize the above problems. Several refinements and modifications are necessary to adapt the experimental models to field use. There is an acute need for better depth control of individual openers when operating in irregular land surfaces. To facilitate cleaning and insure uniform pressure, each dragbar should be individually swung and include a rolling coulter mounted on the same suspension as close to the opener as practicable.

Results of row-spacing studies are still inconclusive, but there is a tendency toward higher yields with the closer row spacings. Likewise, no significant differences in results due to use of various types of tillage points have been obtained. It appears, however, that the selection of both row width and tillage point should be a satisfactory compromise between the wider spacing and minimum tillage combination for best soil and water conservation, and the narrow width and wider opener combination which gives the more complete seedbed

preparation. Any combination of row width and tillage tool used may be greatly affected by seasonal, climatic and soil conditions. However, the best average for Virginia conditions seems to be a row spacing in the 8 to 10-in range and a tillage tool which prepares a row seedbed 3 to 4 in wide and up to 3 in deep. Where seeding is done in an established crop such as alfalfa, the tillage point should be as narrow as possible.

The time and power saved through the use of the multiple-use drill are important factors in its favor. Accomplishment of the complete job of preparing the seedbed, sowing the seed and applying the fertilizer in one operation results in a saving of at least 50 per cent over conventional methods. Continued study over a longer period of time and wider range of climatic and soil conditions with constantly improved machines will be necessary to firmly establish the full application of the multiple-use drill. The potential advantages of the machine warrant that study.

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Agricultural Engineering

(Continued from page 416)

CA

It seems to me that this situation offers agricultural engineers their greatest opportunity. No other professionally trained group can be more practically helpful than agricultural engineers. A few of you have already gone to economically backward lands, and studied how to make our production methods meet their needs and customs. Some of the rest of us have tried to teach a few students from these lands some of our techniques to take home with them.

So far we have made but a small beginning. We need to make a hard, intelligent effort to train men for this kind of service, because such men are generally not available. We need to develop in agricultural engineers a greater sympathy for the people of other lands, an understanding of their problems, knowledge of the difficulty of applying in other lands many of our production-increasing techniques.

There will be need for agricultural engineers in many of the technical-assistance programs requested by economically backward countries who wish to cooperate in such programs of development. As you know, this technical assistance program is often referred to as our Point IV program because last fall in his address to Congress, President Truman listed it as Point IV of our foreign policy. It called for a few millions to supply technical assistance—that specialized guidance to countries who request it and who will supply their own labor and materials. A number of such cooperative development programs are already under way in Latin America. Part of our appropriations are for bilateral development agreements between the United States and other individual countries. A smaller appropriation is channeled through the United Nations for countries which appeal to that agency. In the latter cases, the technical staff is drawn from many countries, and the opportunities for American agricultural engineers are much fewer.

Compared to our billions for military preparations, the few millions expended for technical assistance are entirely inadequate. Yet in such cooperative programs for improving the standards of less fortunate people lies our greatest hope for peace.

A Water Calorimeter for Determining Mean Specific Heats of Solutions

By J. R. Vincent

SOMETIMES, in careful laboratory work, mean specific heats of solutions must be determined with accuracy above that usually given in handbooks. A water calorimeter, made from a vacuum bottle and thermometer, is convenient for this purpose. Such a calorimeter was constructed from relatively cheap materials for use in the poultry respiration calorimeters at Beltsville, Md. In one of the calorimeters, ethylene glycol solution is circulated for the removal of heat.

An important principle in physics is that the exchange of heat between masses in intimate contact goes on until they are at the same or common temperature, provided (1) that the masses are contained so that no heat is added to or lost from the containing calorimeter and (2) that no action involving the internal generation or absorption of heat takes place be-

of a pint-size thermos vacuum bottle, a mercury-in-glass thermometer (1/10°C divisions) and a suitable cork to hold the thermometer. The water equivalent of this system is designated as B grams. As it is convenient to express the heat capacity of the system in terms of its water equivalent, the value was experimentally determined as 23.0 g, as follows: 134.8 g (m_1) of water were added to the system, and the temperature became 40.45°C (t_1). To this was added 131.0 g (m_2) of water at 5.40°C (t_2). The new common temperature became 24.55°C (t_m). Then from the general equation:

$$s_1 (m_1 + B) (t_1 - t_m) = s_2 m_2 (t_m - t_2) \quad [2]$$

$$B = \left(\frac{t_m - t_2}{t_1 - t_m} \right) \times m_2 - m_1 \text{ (grams)} \quad [3]$$

Since $s_1 = s_2$

$$\text{Whence } B = \frac{24.55 - 5.40}{40.45 - 24.55} \times 131.0 - 134.8 = 23.0 \text{ g}$$

Since the specific heat of water is taken as 1.000, the numerical value for mass and heat are equal; therefore, the heat capacity of the system becomes 23.0 cal (calories).

Having found the water equivalent, the specific heat of any added material is easily found from the equation

$$s_2 = \frac{(m_1 + 22.7) (t_1 - t_m)}{m_2 (t_m - t_2)} \quad [4]$$

Out of five determinations the following water equivalents and specific heats of a 21 per cent (by weight) mixture of ethylene glycol and water were found:

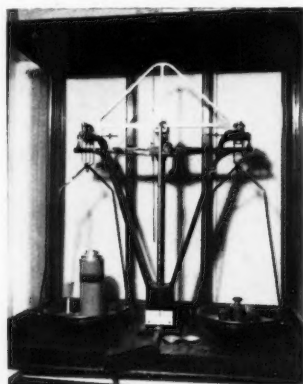
Calories per C	Mean calories per g per C
22.1	0.909
22.9	0.914
23.2	0.899
22.7	0.909
22.2	0.909
Avg. 22.7	Avg. 0.908 at 25 C.

The procedure developed for these determinations was designed for efficiency in labor commensurate with accuracy required. The technique in two steps was as follows:

1 The tare weight of bottle, cork and thermometer was obtained on an analytical balance. A quantity of hot water (about 125 g at 40°C) was added, and the bottle was tightly stoppered. The system was reweighed, and the increment noted as water weight. The bottle was gently tilted top to bottom (to avoid violent agitation) several times. The temperature was observed to be in equilibrium when no change occurred one minute after final tilting. The equilibrium temperature was recorded as t_1 .

2 Another sample of water (about 125 g) at a lower temperature, t_2 , measured to $\pm 0.05^\circ\text{C}$ was added, and the bottle restoppered. Tilting was resumed until the common temperature was reached. The bottle was reweighed and the increment in weight and change in temperature were recorded as m_2 and t_m , respectively.

Substituting these data in equation [2], the "effective" mass of the system in calories per degree C, noted by the letter B as its water equivalent, was found to be 22.7 g-deg per C. To find the mean specific heat of the glycol solution, step one was repeated. In step two the glycol was used in place of water. Substituting in equation [4] the average of five tests showed the specific heat to be 0.908 cal per g per C at 25°C.



Calorimeter on balance as used to show weights of solutions added

tween the masses. By internal heat is meant heat due to molecular activity, such as occurs during fusion, vaporization, recalescence, or mechanical agitation.

The amount of heat involved in any exchange is usually expressed in calories, or in British thermal units, as the amount required to raise or lower a unit mass of pure water one unit of temperature. The thermal capacity of any body is defined by the amount of heat needed to raise that body one degree. It follows that the specific heat of a body is its thermal capacity per unit mass, and is expressed as calories per gram per degree. The specific heat of pure water is taken as 1.000.

The principles pointed out above presuppose that if two bodies of different masses, m_1 and m_2 , and specific heats of s_1 and s_2 at different temperatures t_1 and t_2 , are placed together in a calorimeter, they will in time come to a common temperature, t_m . Therefore, the fundamental calorimetric equation is expressed as

$$s_1 m_1 (t_1 - t_m) = s_2 m_2 (t_m - t_2) \quad [1]$$

The specific heat of ethylene glycol solution used in one respiration calorimeter was determined directly by means of a vacuum-bottle calorimeter. The calorimeter system consisted

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Use of Radiant Energy for Corn Borer Control

By H. H. Beaty, J. H. Lilly and D. L. Calderwood

MEMBER A.S.A.E.

ASSOCIATE MEMBER A.S.A.E.

A RESEARCH project on the use of radiant energy to control the European corn borer was started in Iowa in 1949 as a cooperative project between the Iowa Agricultural Experiment Station and the Division of Farm Electrification, U.S. Department of Agriculture. The main objective of the project was to determine the possible value of electric lamps and traps as a method of field control of the European corn borer moth.

1949 Experiments (1)*. Two fields of sweet corn were selected, each rectangular in shape and about 25 acres in area. Four light traps were used and each had five 360 BL fluorescent lamps, 36 in in length and rated at 30 w each, as a light source. A 36 x 36 in commercial fly-killing screen with $\frac{3}{8}$ -in c-to-c spacing between grids was used to electrocute the moths. Transformers rated at 3500 v and 10 ma were used to charge the grids. These traps were placed 200 ft apart in a straight line down the center from one end of each field.

The traps were put in operation in the early field in late May. Troughs were placed under the traps to catch the

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AUTHORS' NOTE: The Green Giant (formerly Minnesota Valley) Canning Co., General Electric Co., Gardner Mfg. Co., Marshall County Rural Electric Cooperative, Iowa Electric Light and Power Co., Killer Cage Co., Acme Products Co., King Light Trap Co., Gilman Wright, Mediapolis, Ia., Agriculture Service Co., and Roy Chadwick, Nevada, Ia., cooperated in this study.

*Numbers in parentheses refer to the appended references.

electrocuted moths. However, attempts to get accurate counts of the kills were abandoned, since many moths were completely destroyed and most of the others were badly burned.

Heavy moth flights caused clogging of the screens and shorting of the transformers. The egg mass count in the field remained fairly low during the early part of the flight, prior to plugging of the traps.

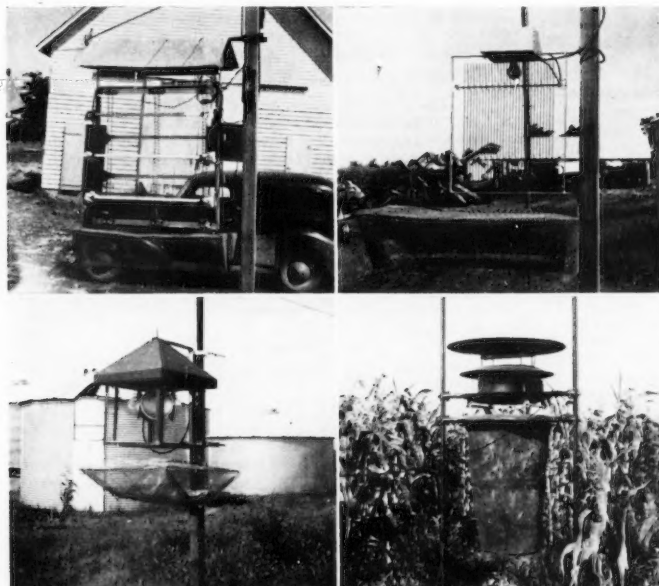
A survey of the borer damage in this field was made on June 24, 1949. Infestations of about 50 per cent were recorded in the vicinity of the traps, with infestations up to 80 per cent in the outlying portions of the field. The infestation was lighter in the direction of the prevailing wind (to the west of the traps). However, these data were not considered conclusive because the traps were inoperative much of the time from plugging and shortening as a result of the heavy moth flight.

The four traps were moved to a field of late sweet corn for the second-brood moth flight. Two of the $\frac{3}{8}$ -in grids were replaced with grids having a $\frac{1}{4}$ -in c-to-c spacing. The results in the late field were also inconclusive, since the traps with the $\frac{1}{4}$ -in grid spacing also plugged during heavy moth flights. The $\frac{1}{4}$ -in spacing proved to be too wide for effective kill with the transformers available. Tests with 7500-v transformers with outputs of 30 ma proved quite effective in clearing plugged grids of moths, but these could not be kept in use because of the dangerous current output. Fifteen milliamperes short-circuit current is considered the maximum safe allowable current output (2).

A survey of egg masses on August 16 showed counts of 209, 249, 138 and 215, respectively, on groups of 10 plants in the immediate vicinity of the four traps, far more eggs than were found anywhere else in the field. In this late field, the moths showed a marked tendency to come near the traps and then come to rest on tall corn. The result was a high concentration of egg masses in close proximity to each of the four traps.

1950 Experiments. In setting up the experimental program for 1950, a 5-acre field of early sweet corn located one mile south and $\frac{1}{2}$ mile east of Ames was selected. Three of the four traps were placed outside the field, about 100 ft from the nearest corn. The traps were located outside the corn field with the hope that many moths would be killed before they entered the field and started to lay their eggs. A field of sweet corn planted the same day (May 1), located about $\frac{1}{2}$ mile to the north, was selected as a control field for comparison with the lighted field.

Each of the traps used five 30-w, 360 BL fluorescent tubes made by General Electric as the attracting element. Grids 3 x 3 ft square with $\frac{1}{2}$ -in c-to-c spacing between alternate bars, manufactured by the Gardner Mfg. Co., Horicon, Wis., were used as the killing elements. They were intended for use with transformers rated at 6,000 v on the secondary with open circuit, and 12 ma secondary short-



Some experimental and commercial light traps used in the 1950 Iowa Corn borer moth experiments. Fig. 1 (Upper left) Experimental trap No. 4. • Fig. 2 (Upper right) Commercial trap No. 1. • Fig. 3 (Lower left) Commercial trap No. 2. • Fig. 4 (Lower right) Gardner suction-type light trap.

circuit current. However, these transformers did not arrive in time to be used in this experiment. From June 8 to 16 the transformers were the same ones used with the narrow grid spacing in 1949. They were rated at 3500 v open circuit, and maximum short-circuit current of 10 ma. The 1/2-in grids again plugged on nights when moth flights were heavy. When this was discovered, a man was employed to clean the moths out of the traps in order to keep the grids operating. New transformers were secured and operated from June 16 until July 21 when the traps were disconnected. These were rated at 6000 v open circuit and 30 ma short-circuit current. A 250,000-ohm resistance was added in series with the secondary output to reduce the short-circuit current to 15 ma. Considerable trouble was experienced with these resistance units. It was necessary to use two fixed resistance units of 100,000 ohms each, and one 100,000-ohm variable resistor. These resistors were rated at 100 w each.

The four traps were operated nightly from June 8 to July 21. A time clock was used to turn the traps on at 8:00 p.m. and off at 4:00 a.m.

Two kinds of data were taken. First, four separate counts of egg masses were made on marked hills at different locations throughout the field. Second, ear samples taken from different parts of the field were examined for corn borer damage just prior to harvest. A heavier egg mass count was found in the control field than in the lighted field. The control field was sprayed three times to avoid excessive crop loss.

CORN BORER DAMAGE LESS IN LIGHTED FIELD

Samples of 50 ears each were taken at several locations in both fields just before harvest. The ears were husked by hand and examined for borers and borer damage in the trapped field. An average of 35 per cent were free from corn borer damage. In the control field which had been sprayed three times, 77 per cent of the 250 ears picked were free of corn borer damage.

No attempt was made to count the moths killed by the traps during this first flight of corn borer moths.

Light Traps in Late Sweet Corn Field. When the first flight of corn borer moths tapered off, the traps that had been in the early field were moved to a 20-acre field of late sweet corn located one mile north and one mile east of Ames. Three traps were set within the field and one was located in a country school yard about 40 ft from the north end. Baskets were placed under each of the traps and daily counts were made of the number of corn borer moths killed. The total nightly kills of each of these traps were also weighed. The following table summarizes the results for the period from August 13 through September 6, 1950.

Trap No.	Wt. (grains) all insects	No. corn borer moths	Per cent females
1 (yard)	25,935	333	67
2 (corn)	16,650	841	64
3 (corn)	15,830	865	60
4 (corn)	17,965	985	64
Totals	76,380	3030	63

The light traps used were the same as those used in the early sweet corn field, except that they were equipped with the new transformers from the Kenyon Transformer Co. These were rated at 6,000 v open-circuit secondary voltage and 4 ma short-circuit current. By removing core laminations in a magnetic shunt, the short-circuit current was boosted and the voltage output was increased. The following readings were taken after these changes had been made:

Trap No.	Short-circuit current, ma	Open circuit voltage
1	10.5	8000 v
2	12.0	8600 v
3	12.0	8600 v
4	10.5	8000 v

The transformers appeared to do a good job of killing all the insects that came in contact with the grids. Also, the

moths were not badly burned so that they could be counted with reasonable accuracy. However, there were no heavy moth flights while the traps were in operation so they did not have a severe test. Some difficulty was experienced with these transformers because of arcing across the 1/2-in-spaced grids. It was necessary to put in as much as 300,000 ohms resistance in series with the secondary to stop spontaneous arcing.

A comprehensive egg mass count was not made in this field. A thorough count was contemplated when at least 5 egg masses were found on five plants selected at random. Although five plants were examined daily no more than two masses were found at any time.

Just before harvest five 40-ear samples were picked. Seventy-five per cent of the ears were free of corn borer damage beneath trap No. 3, and this was the heaviest infestation found. Because of the light infestation it was impossible to determine whether or not the light traps had any effect in this field.

High Intensity Light at Trapping Center. Two 1000-w mercury-vapor lights were installed in the farm yard at the Agricultural Engineering Farm 3 miles south of Ames. The object was to attract corn borer moths from a distance to a small area outside of a corn field. The 1000-w lights were mounted near the top of a 30-ft pole. Light traps were set up beneath these lights to attempt to attract and electrocute the moths attracted to this area.

The mercury-vapor lights were turned on June 13 and were operated nightly until July 21. They were turned on again August 11 and were in operation until September 6.

Moths were not attracted in numbers to any of the light traps while the 1000-w mercury-vapor lights were in operation, although the large lights did attract many insects to this area on favorable light nights. No way was found to determine the distance from which the large lights would attract moths.

A survey was made in a nearby corn field on July 6 to get a record of old and fresh egg masses, and plants with shot-hole damage, to determine whether or not there was any difference in the numbers of egg masses or injured plants at various distances from the location of the 1000-w mercury-vapor lights. No consistent trends or differences were found.

On August 14 a time clock was installed in the circuit with the mercury-vapor lights to turn them on and off at hourly intervals. The object was to have the traps operate part of the time without competition with the 1000-w mercury-vapor lights.

EFFORT MADE TO FIND MOST EFFECTIVE TRAP

The traps in this area were of various types. It was hoped that some information might be obtained as to which of the several commercial and experimental traps was most effective.

During this period baskets were placed under each of the traps and a daily count was made of the corn borer moths killed. The results were as follows:

Trap	Lights	Corn borer moths killed	Per cent females
Commercial Trap No. 1	150-w incandescent	212	51
Commercial Trap No. 2	1200-w incandescent	515	61
Experimental Trap No. 3	150-w fluorescent	717	61
Experimental Trap No. 4	150-w fluorescent	479	63

The numbers of moths killed by each of these traps were too small to permit a conclusion that any one was superior or inferior to the others.

Pictures of three of the traps used in the trapping center are shown in Figs. 1, 2, 3. Two other commercial traps obtained for this experiment had to be discarded because of mechanical defects.

Experimental Suction-Type Light Trap. An experimental suction-type light trap (Fig. 4) designed and built by the Gardner Mfg. Co., Horicon, Wis., (Continued on page 426)

A Method of Evaluating Tractor Transmissions

By J. Arthur Weber

MEMBER A.S.A.E.

FARM tractors are used to provide power for field operations at many travel speeds over a wide range of conditions. The average field operating speed has increased considerably since rubber tires have been used on tractors. Some field operations such as rotary hoeing must be done at high travel speed so the machine will do effective work. On the other hand, for such operations as combining, very slow speeds are required. Some tractors have a broadened range of speeds, but many still fail to provide certain speeds which are desirable for most economical and effective operation. This need is evidenced by the fact that extra gear units are being manufactured by specialty companies to provide additional speeds for some tractors.

The purpose of this paper is to point out that the present gear transmissions are not completely satisfactory. This is done by means of a new graphic method of showing the ground speeds and drawbar pulls that can be obtained with any particular tractor.

A tractor transmission may have very good mechanical efficiency, but be ineffective in providing the proper ground speeds for the most efficient use of fuel, labor or equipment. This latter factor may have a greater effect on over-all operating efficiency than the straight mechanical efficiency of the transmission. Since a selection of several ground speeds is desired for different farm operations and conditions, a transmission is most efficient (1) when, it provides the desired ground speed with required drawbar pull to utilize the full horsepower of the engine, and (2) if the desired ground speed for light-draft operations can be obtained at reduced engine speed to secure maximum fuel economy.

With present gear transmissions maximum engine horsepower can be used at only one ground speed and one drawbar pull in each gear ratio. The ground speeds and maximum drawbar pulls obtained in the Nebraska test for a two-plow tractor have been plotted in Fig. 1. These points, one for each gear, fall on a curve of maximum drawbar horsepower for

this tractor. The engine could handle any load and ground-speed combinations under this curve, but because of the limitations of gear transmissions, not all of these speeds and pulls are available, at the drawbar.

Now by means of an analysis of load-speed curves it will be shown which areas under these curves are unavailable. That is, the load and speed combinations which cannot be used and which therefore reveal the inadequacy of the tractor transmission illustrated. These loads and speeds are discussed (1) for machines which do not require rated engine speed and (2) for the many power-take-off operations requiring rated engine speed.

The variable load-speed curves, presented later, were obtained by combining results of the University of Illinois belt tests for the tractor of Fig. 1, with Nebraska tests on this same tractor. Varying-load belt tests gave the engine torques and speeds which were used to complete the full governed speed-pull curves for each gear as shown in Fig. 2. In addition to the full speed tests, varying-load belt tests were made with hand-throttle lever* set at $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ -open positions (Fig. 3). Results of these tests were used to obtain the results given in Table 1 and presented graphically in Fig. 4 to show the drawbar performance at reduced engine speed.

The highest ground speeds in each gear are obtained with throttle lever fully open so the engine operates at rated governed speed. For this fully open setting, the ground speeds at all loads in each gear are shown in Fig. 2. The speeds are for the same tractor as presented in Fig. 1. As the load is reduced, there is a slight increase in ground speed in each gear, due to the action of the governor and the decrease in wheel slippage. In Fig. 2, the Nebraska maximum drawbar horsepower for each gear was plotted in terms of pull and ground speed. The engine torque and engine speed at the maximum belt horsepower obtained in the laboratory were set coincident with these points. Results from belt tests could be used since en-

*It is understood that the so-called hand-throttle lever of the tractor is a governor-control lever rather than a true throttle, in that it does not directly control the fuel supply or butterfly valve. However, in view of the popular use of the term, it will be called a throttle lever in this paper.

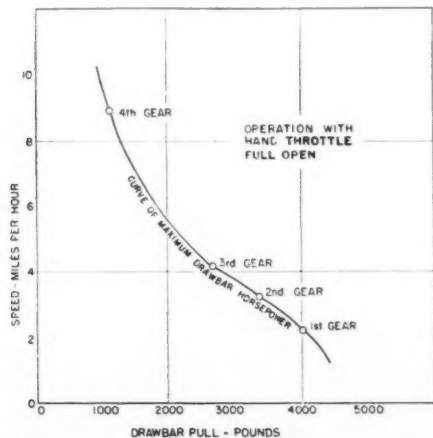


Fig. 1 Maximum drawbar pull and ground speed for each gear for a two-plow tractor, taken from official Nebraska tractor test

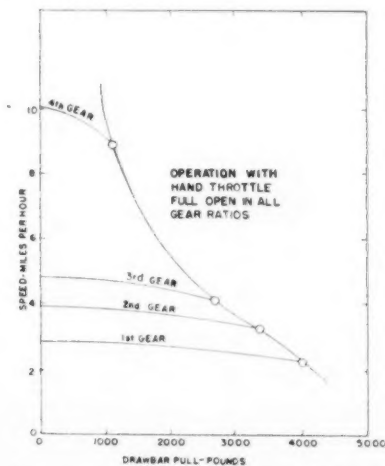


Fig. 2 Ground speed and drawbar pull in each gear ratio

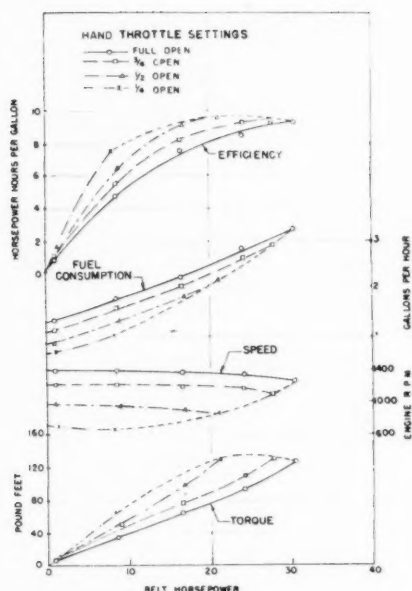


Fig. 3 Effect of reduced engine speed on engine performance

gine torque is proportional to drawbar pull and in any one gear engine speed is proportional to ground speed.

The speed-versus-pull curve for full governed-speed operation and the maximum power for each of the lower speed settings determine the boundary or working range of each gear. Fig. 4 shows the working range for third gear of the

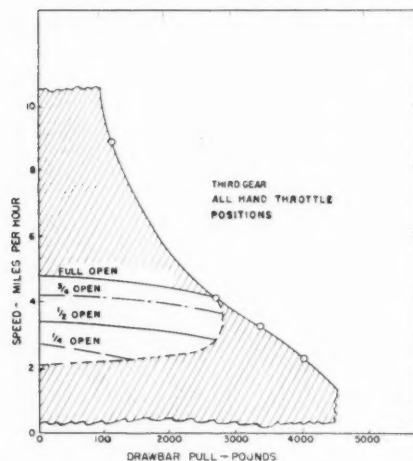


Fig. 4 All possible combinations of ground speed and drawbar pull in third gear

tractor tested. The speed and drawbar pull combinations located within the area shown are the only combinations that can be obtained in third gear regardless of the throttle-lever setting.

The same belt test data and procedure were used to obtain the working range of the other gear ratios. The working range for each of the gear ratios of the tractor tested is given in Fig. 5. The range of each gear ratio touches the curve of maximum drawbar power at only one point (full load, engine full speed). This leaves areas which include combinations of ground speeds and pulls not covered by any gear ratio. The engine is capable of handling all ground speed and pull combinations in these areas, but, because of the gear-ratio arrangement, they are not available at the drawbar.

If sufficient gear ratios are not provided, desirable combinations of drawbar pull and speed are omitted entirely, and at other speeds very little drawbar pull is available. For example,

TABLE 1. CALCULATED DATA FOR DRAWBAR PULL VERSUS TRAVEL SPEED CURVES SHOWN IN FIG. 4 FOR TRACTOR OPERATED IN THIRD GEAR

Load	Belt hp	Engine speed ¹ rpm	Rear-wheel speed ² mph	Slip ³ %	Tractor speed, mph	Engine torque ⁴ ft-lb	Drawbar pull, ⁵ lb
Wide Open Governor Control Lever Setting							
Max.	30.12 ^{††}	1257	4.44	6.4	4.16*	127.0	2691*
3/4	24.12	1328	4.69	4.6	4.47	95.5	2022
1/2	16.71	1355	4.78	3.2	4.63	64.8	1372
1/4	8.63	1388	4.90	2.8	4.76	32.6	690
0	4.12	1392	4.92	2.0	4.82	1.2	89
3/4 Governor Control Lever Setting							
Max.	27.83 ^{††}	1110	3.92	6.8	3.65	131.8	2792
3/4	24.20	1162	4.12	5.1	3.90	109.2	2312
1/2	16.66	1192	4.22	3.8	4.06	73.4	1555
1/4	8.56	1203	4.25	2.8	4.13	37.4	792
0	4.13	1213	4.28	2.0	4.19	5.3	112
1/2 Governor Control Lever Setting							
Max.	21.17 ^{††}	856	3.02	6.5	2.82	130.0	2753
3/4	17.00	907	3.21	4.8	3.06	98.3	2082
1/4	8.86	953	3.37	3.0	3.27	48.8	1034
0	4.06	982	3.47	2.0	3.40	5.7	121
1/4 Governor Control Lever Setting							
Max.	8.24 ^{††}	661	2.34	3.5	2.25	65.4	1385
0	4.03	776	2.74	2.0	2.69	7.0	148
Idle							
0	0 ^{††}	600	2.12	0	2.12	0	0

*Obtained from Nebraska test.

†Obtained from Illinois belt tests of same make and model.

‡Rear wheel speed directly proportional to engine speed.

**Per cent slip estimated from Nebraska tests.

††Drawbar pull directly proportional to engine torque.

†††Engine loaded to give maximum belt horsepower.

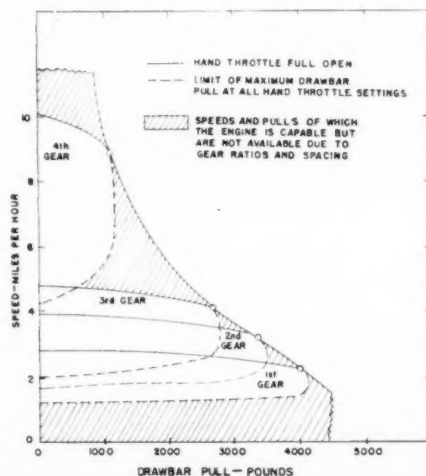


Fig. 5 Gear diagram showing range of ground speed and drawbar pull for all gear ratios

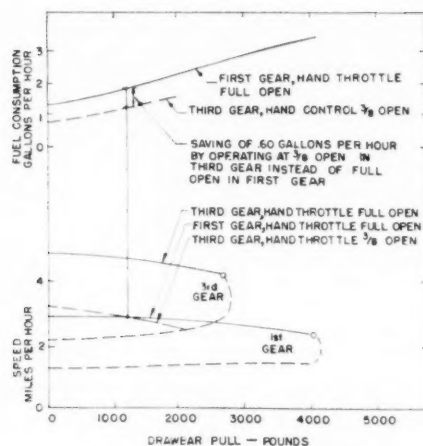


Fig. 6 Fuel savings at reduced engine speed

from Fig. 5, this tractor cannot be used to pull a 1,500-lb load at 5 mph. The engine has the horsepower needed for this task, but a transmission-gear ratio for this combination has not been provided. It would be possible to pull 1,500 lb and even up to 2,600 lb in third gear, but the ground speed would be only 4 mph. However, to be able to travel at 5 mph necessitates a change to the fourth-gear ratio and a lower engine speed. But, when the engine is throttled down to 5 mph in fourth gear it is capable of only 800 lb pull at the drawbar. These vacant areas of loads and speeds often make it nec-

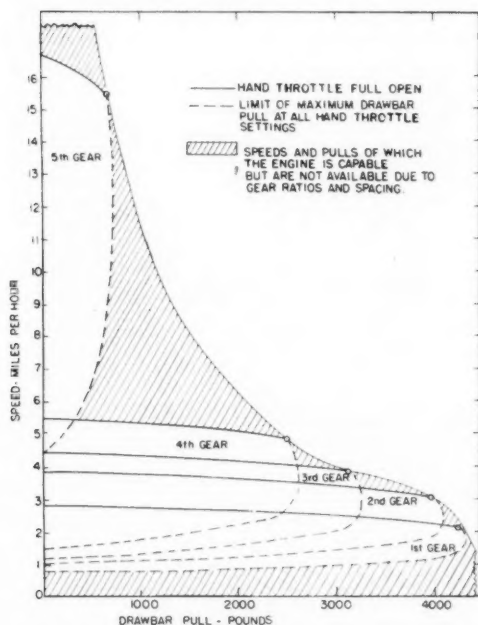


Fig. 7 Range of ground speed and drawbar pull for all gear ratios for a three-plow tractor

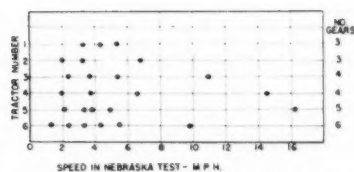


Fig. 8 Non-uniformity of forward travel speed selection provided by gear ratios on six common tractors

essary to operate loads at slower travel speeds than a tractor with a little less horsepower. This is possible due to the smaller tractor being provided with a gear ratio that provides a little faster travel speed. This leaves the impression that the smaller tractor has the greater power or the wrong deduction that the larger tractor is in need of repairs.

The choice of operating speeds is enlarged and significant fuel savings can be made by operating at a lower engine speed. The most economical operation can be obtained by operating at the slowest engine speed at which it will pull the load as shown in Fig. 3. The operator can take advantage of this fuel-saving practice when a good selection of gear ratios is available as the same drawbar pull and ground speed can be obtained in two and sometimes three gear ratios by operating the engine at different speeds. Fig. 6 shows an example of fuel saving at a part throttle setting for light load. Shifting from first to third gear for the same load reduced the engine speed and made a saving of fuel. Shifting from first to second gear resulted in a smaller saving but made more reserve pull available. Other examples are given in Table 2. Savings at reduced engine speeds are possible only on tractors which have a liberal selection of gear ratios.

TABLE 2. FUEL SAVINGS BY OPERATING IN HIGHER GEAR AND AT LOWER ENGINE SPEED*

Gear used	Speed, mph	Drawbar pull, lb	Position of throttle lever	Fuel consumption, gal/hr	Fuel saving, gal/hr	Saving, %
2	5.7	2,000	Full	2.47		
3	5.7	2,000	$\frac{3}{8}$	2.13	0.34	13.8
1	2.2	3,250	$\frac{3}{4}$	2.62		
2	2.2	3,250	$\frac{1}{2}$	2.21	0.41	15.6
1	2.7	1,500	$\frac{7}{8}$	1.87		
2	2.7	1,500	$\frac{1}{2}$	1.46	0.41	21.9

*Determined from laboratory belt tests of a two-plow tractor and diagrams of ground speed versus drawbar pull.

When using the power take-off, the working range of each gear is limited to ground speeds at rated engine speed. Machines such as power-take-off combines, corn pickers, hay choppers, and balers must be operated at or near their rated speed. For example, in Fig. 5, if this tractor is to pull a power-take-off machine which requires a drawbar pull of 1,500 lb, there is a choice of three ground speeds: 2.6, 3.6 and 4.4 mph. Since most efficient machine operation might be at other ground speeds for the varying field conditions, it would be desirable to have tractor transmissions that would provide an infinite selection of ground speeds with constant power-take-off speed.

A fairly accurate speed-pull diagram for any tractor can be constructed from data given in the official Nebraska report. The speed-pull gear diagram for a popular three-plow tractor was made by using the Nebraska test data on speed and pull in each gear as given in Fig. 7. The maximum and minimum no-load engine speeds in each gear were calculated from no-load engine speed at full throttle lever setting and engine idle speeds, respectively. Since no tests were reported from Nebraska in fifth gear, it was necessary to estimate the speed and drawbar pull for this ratio.

This particular tractor has a good selection of gear ratios from 2 to 5 mph, but does not have a ratio which can be used in the field above 5 mph. The fast fifth gear cannot furnish the drawbar pull necessary to do field work or start heavy

loads on the road. Maximum field speed for this tractor, for light-draft operations such as harrowing and rotary hoeing, is near 5 mph at full engine speed. There is no opportunity to shift to a higher travel speed gear for none has been provided.

Field records were taken on two tractors of this model over a period of several years. Time service recorders gave a record of the operating time and the farmer recorded the type of work and gear ratio he was using. Table 3 gives the results

TABLE 3. HOURS OF TRACTOR OPERATION IN EACH GEAR DURING ONE SEASON

Operation	TRACTOR A*				
	First gear, hr	Second gear, hr	Third gear, hr	Fourth gear, hr	Fifth gear, hr
Plowing			82.5	42.0	
Disking				32.9	
Harrow				10.4	
Disk and harrow		4.8		118.3	(No field work done)
Spring-tooth harrowing				5.4	
Cultivate				114.9	
Combine			52.2		
Corn picking	10.2	102.4			
Hauling				10.4	
Total time (587 hours)	10.2	107.2	154.7	334.3	
Per cent of total time	1.7	18.5	22.9	57.1	

Operation	TRACTOR B*				
	First gear, hr	Second gear, hr	Third gear, hr	Fourth gear, hr	Fifth gear, hr
Plowing			95.6	33.7	
Disking			3.9	88.0	
Harrow				24.7	
Harrow and disk		8.1	9.1	2.8	(No field work done)
Spring-tooth harrowing			7.8	11.0	
Rotary hoe				18.7	
Cultivate			1.5	35.8	
Combine	19.8		42.2	38.1	
Mowing				8.6	
Corn picking	23.3	73.0	4.0		
Hauling				2.9	
Total time (552 hr)	43.1	81.1	164.1	264.3	
Per cent of total time	7.8	14.6	29.7	47.9	

* Tractors were same make and model; three-plow size.

† Advertised speeds mph: first 2½, second 3½, third 4¼, fourth 5½, fifth 16¾.

for typical years. In both cases, about one-half the operating time was in fourth gear (5 mph). Operations listed for this gear ratio that could have been done better and more economically at a faster ground speed or at the same ground speed with a reduced engine speed include hauling, harrowing, cultivating, and rotary hoeing. Both of these tractors were on farms where more than one tractor was available for field work. Many times the operations just mentioned were done by the other tractor because it had a travel speed about 8 mph.

What ground speeds should be available and how many selections should there be? The speeds now available on different tractors is evidence that not all the thinking has been clarified on this subject. The advertised speeds for six common tractors are shown in Fig. 8. Certainly in these six, there has been no standardization of either the speeds or number of selections.

The most efficient field speed for any operation is influenced by such factors as (1) the operation performed, (2) power available, (3) power required, (4) condition of soil and crop, (5) precision desired for guiding, (6) ease of operation, (7) safety, and (8) comfort of the operator.

It would take a tremendous amount of study to determine the most efficient speed for each operation under all conditions. Investigation would undoubtedly prove that it is desirable to have an infinite selection of speeds available between a crawler speed and a safe road speed.

Most of the tractor manufacturers are now recognizing the need for a larger selection of working speeds and are building transmissions with as high as eight forward speeds. Independent manufacturers have recognized a market for gear boxes

and overdrives which will increase the ground-speed selection for tractors already on farms. Hydraulic clutches are being used on combines and have been used on at least two tractors. These give an infinite selection of speeds by allowing hydraulic slip and loss in tractive power. These clutches do, however, permit constant engine and power-take-off speeds with variable ground speed that is particularly desirable for power-take-off operations of combining, corn picking, mowing, baling, etc. A more complete discussion of hydraulic transmissions has been presented by Frudden† Shurts‡.

All of these changes indicate progress. However, we still have a lot of work to do before we can provide the farmer with a tractor transmission that has the desired infinite selection of ground speed and make full drawbar power available at any speed. With such a tractor the farmer could save fuel and labor, regulate travel speed so machinery would do its best quality of work.

† Frudden, C. E.: Application of Torque Converters in Farm Machines. AGRICULTURAL ENGINEERING, vol. 30, pp. 423-425 (September, 1949).

‡ Shurts, W. E.: Present Status of Hydraulic Torque Converter Development. AGRICULTURAL ENGINEERING, vol. 30, pp. 426-428 (September, 1949).

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was operated during the summer of 1950 as part of the light trap experiments.

This trap used four 15-w fluorescent BL tubes as the attracting source. The insects that came sufficiently close to the lights were sucked into a wire basket by an electric fan mounted in the top. From June 13 to July 23 this trap was located in an oat field near Nevada, Iowa. The field had been planted to corn in 1949 and a large number of borer moths emerged from it in 1950.

With this trap it was possible to make an accurate count of the number of moths caught each night. During the first moth flight from June 13 to July 23, over 23,000 corn borer moths were caught in it. About 21,000 were caught during the 10-day period from June 13 to June 23.

Before the second moth flight this trap was moved into the adjoining corn field. During the period from August 12 to September 6 a total of 2111 moths were caught, 53 per cent of which were females. During approximately the same period 333, 841, 865, and 985 moths, respectively, were caught in the four electrocuting grid-type traps in the late field of sweet corn near Ames.

The suction trap used 86 kw-hr of energy from August 9 to September 7, a period of 29 days. It was operated 13 hr a day, so its power requirement was 228 w.

Heat Trap. Another experimental light trap commonly referred to as a "heat trap" was tested in 1950. It consisted of a reflector and socket for an ordinary incandescent light bulb. Approximately 4 in under this reflector a galvanized bucket of about 1-gal capacity was located. In this bucket a 500-w heating element was mounted. This trap was installed on the transformer pole at both of the lighted sweet corn fields. From June 20 to July 20, 6724 moths were killed by it. From August 8 to September 6, 1075 moths were killed, 46 per cent of which were females.

This trap was built by Gilman Wright, Mediapolis, Iowa. It is simple in design and could be produced for much less than the cost of the electrocuting traps. The power requirement for the heating element is quite high.

CONCLUSIONS

1 The numbers of moths attracted to the light sources were much smaller in 1950 than in 1949. The light source was the same for both years.

2 Satisfactory commercial control of first-brood borers was not achieved by four electrocuting light traps around a 5-acre field of canning sweet corn in 1950. An average of 74 per cent of the harvestable ears (Continued on page 429)

Subsoil Conditioning on Claypans for Water Conservation

By Dwight D. Smith

MEMBER A.S.A.E.

CONDITIONING of the subsoil layer immediately below the surface by shattering and liming has given increased top and root growth and moderately higher crop yields on the Midwest Claypan Soil Conservation Experiment Farm, McCredie, Mo. Early results of runoff measurements indicate that the volume in the soil for water storage and the utilization of water by plants are increased. The latter results from the more vigorous crop growth that is supported by the improved soil physical and fertility conditions. Consequently, surface runoff is decreased.

Results for the first period of the study, including a discussion of the fertility phase, were reported in AGRICULTURAL ENGINEERING for August, 1947 (1)* and in Soil Science Society of America Proceedings, (vol. 11) (2). Since that time, the studies have been expanded to include additional crops and to provide for measurement of rate and amount of runoff on areas of field size. Development of machines for application of the process to the field areas has been a part of the study. This article is a progress report on these later studies.

Why Subsoil? Heavy subsoiling machines frequently referred to as pan breakers have been in successful operation for more than 20 years. A hard pan or cemented layer relatively impervious to air, water, and plant roots, located be-

tween the surface soil and a pervious subsoil, is broken by the operation. This improves the internal drainage of the surface soil and allows freer movement of air and water and deeper rooting by growing plants. Subsoiling on areas underlain by claypan, or zones of deep plastic clay, has not been successful in most cases. It has not been possible on these areas to penetrate through the plastic clay horizon. Operation of the subsoiler when the clay contained sufficient moisture to be plastic only aggravated the condition. Our studies at McCredie have shown that the subsoil can be shattered satisfactorily when dried to a moisture content of about 16 per cent or less. This alone has been of little value. In fact, wheat and corn yields were decreased when the high acid and low nutrient content of the shattered zone was not corrected. This suggests that the main function of shattering may be the mixing of amendments throughout the shattered zone.

The Problem of the Claypans. Absorption of rainfall by the claypan soils depends largely on the moisture content of the surface soil at the beginning of the rain and on maintenance of an infiltration capacity greater than the rainfall rate. Infiltration data were secured by the tube method before starting the research program at McCredie. These tests on areas of both Class 1 and Class 3 erosion showed only 0.16 in of absorption in 3 hr when the tests were done on wet soil. One-half of this occurred during the first hour. The infiltrometer tube in these tests extended at least 12 in into the claypan. Percolation tests on 3-in saturated core samples of the claypan layer have indicated transmission rates of only 0.01 in per hr or less. Since 60 per cent of our annual rainfall occurs at rates equal to or greater than 0.2 in per hr, these claypan soils have a potential for large amounts of runoff, particularly if they have suffered severe erosion and are improperly cropped. For this reason they have been considered erosive soils in spite of their favorable topography.

Data by Woodruff (3) indicate that the surface 15 in, which includes the grey layer and subsoil transition, will hold at field capacity 4.73 in total moisture and 3.12 in air. Assuming that 90 per cent of this air space can be occupied by absorbed rainfall, the total storage volume for water is 7.54 in. About one-third of this amount (2.58 in) is not available for plant use. It is the amount present when the soil moisture is at the plant wilting point.

Although these data may indicate a large capacity to absorb water, it is seldom that the soil will be depleted of all or most of its moisture when a rain occurs.

A high saturation deficiency, or, in other words, a large storage capacity for water in the soil at the beginning of a rain, is necessary for maximum absorption of rainfall. Means must be developed for maintaining this storage capacity at a

This paper was presented at a meeting of the Mid-Central Section of the American Society of Agricultural Engineers at Columbia, Mo., April, 1951. Contribution of the cooperative project, Midwest Claypan Soil Conservation Experiment Farm, McCredie, Mo., Soil Conservation Service, U.S. Department of Agriculture, and Journal Series paper No. 1258 approved by the Director, Missouri Agricultural Experiment Station. Development and operation of this part of the project has been jointly with C. M. Woodruff, soils department, University of Missouri, and D. M. Whitt, Soil Conservation Service, (Research), USDA.

The author: D. D. SMITH, project supervisor, Soil Conservation Service (Research), USDA, Columbia, Mo.

*Numbers in parentheses refer to the appended references.

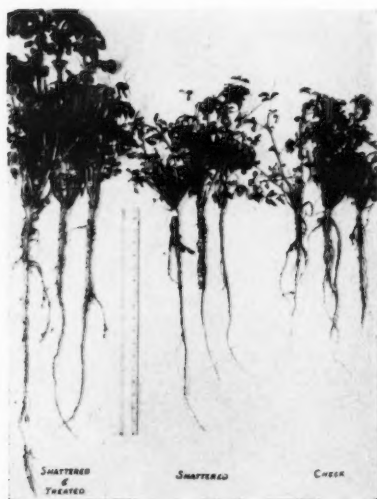


Fig. 1 Sweet clover root development on the claypans is changed by deep liming and shattering from the short and branched system to the deep and relatively unbranched systems typical on the deep pervious soils

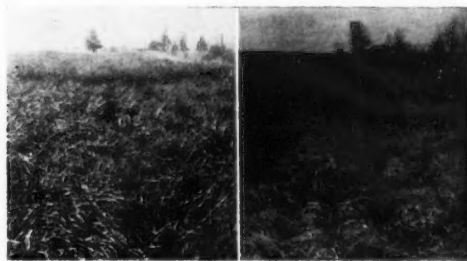


Fig. 2 Tall fescue, with its deep vigorous root system and ability to produce abundant top growth late in the fall, is excellent for terrace outlets. (Left) Fescue on a shattered and deep-treated outlet in October, 1949, one year after seeding. (Right) Same outlet in March, 1950

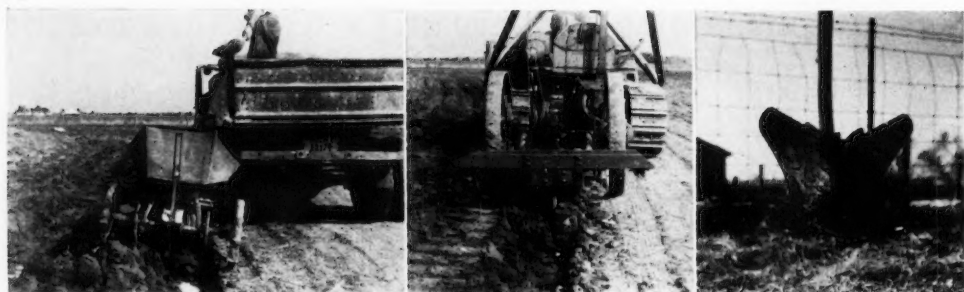


Fig. 3. Equipment used on the Midwest Claypan Soil Conservation Experiment Farm for deep liming and shattering. (Left) Dump truck and lime spreader metering lime to bottom of 9-in plow furrow. (Center) Subsoiler working about 16 in deep following placement of the lime. (Right) Close-up of subsoiler shank with small lister share for lifting and shattering the dry subsoil

maximum. Since very little moisture can percolate downward, it must be removed upward. This is done by evaporation and plant transpiration. While evaporation may be high from a bare soil during the warm summer months, rainfall impact soon seals the surface and restricts infiltration, resulting in high runoff and erosion. A mulch of dead vegetation insulates the surface and retards evaporation. Thus, the answer is the growing of crops that will transpire a maximum of moisture throughout a maximum number of months of the year. This utilization of moisture already in the soil is the major requirement for absorption of the rain to come.

Unfortunately these soils do not normally have sufficient fertility for maximum plant growth and, hence, maximum transpiration. Thus a fertility program is an essential part of a moisture program on the claypans. Also, selection of crops and treatments which will increase transpiration of moisture by plants and extend it into the winter and early spring, when the common intertilled crops are not growing, is essential. The 6-month, over-the-winter period, beginning with November and ending with April, has 36 per cent of the annual rainfall but produces practically 50 per cent of the annual runoff. During this period 40 per cent of the precipitation becomes runoff in comparison with 23 per cent during the 6-month growing season. These data are from the 153-acre drainage area of the experiment farm reservoir. About 40 per cent of the area has been in grain crops, including small grain-lespedeza, 40 per cent in untreated redtop-lespedeza meadow, and 20 per cent in untreated bluegrass pasture.

Experimental Results—Yields. During the original period of this study the increase in corn yield resulting from the treatment reached a maximum the third year after treatment. It then declined, and for the sixth year there was not a significant difference. Check plot yields were about the county average.

The relative increase for each year was as follows:

1st year	0 per cent	4th year	46 per cent
2nd year	22 per cent	5th year	13 per cent
3rd year	58 per cent	6th year	-3 per cent

This, with the re-valuation of the theoretical effects of the treatment, was sufficient evidence to warrant retreatment. This was done in the fall of 1947. Four tons lime and one ton rock phosphate per acre were mixed into the 9- to 16-in soil layer by the shattering process. Surface treatments of fertilizers for all plots were revised, based on soil test data. On the corn plots, sufficient ammonium nitrate was added for a calculated yield of 125 bu per acre. The rotation was changed to a corn-soybeans-wheat and sweet clover. Only the grains were harvested and removed.

There has been a consistent yield increase from soybeans as a result of the treatment. While not spectacularly high, it has been enough to pay the cost of the treatment. Adverse soil moisture on the lower strip in corn during 1949 reduced the stand on the deeply treated plots sufficiently to reduce the

yield. Yield reductions from shattering without deep liming were considered due to the dilution of the surface layer with the subsoil in the shattering process. That the addition of the lime to the lower layer has overcome the effects of the surface soil dilution is taken as evidence that the process has definite potentialities, but that cropping over a somewhat longer period will be required for development of the deeper layer into a highly productive soil that will resist droughts.

Sweet Clover Root Development. The process has been very effective in changing the root development of sweet clover from that typical of claypan soils to that found on the more pervious soils. This has been reflected in increased top growth. Representative sweet clover plants dug from these plots are shown in Fig. 1.

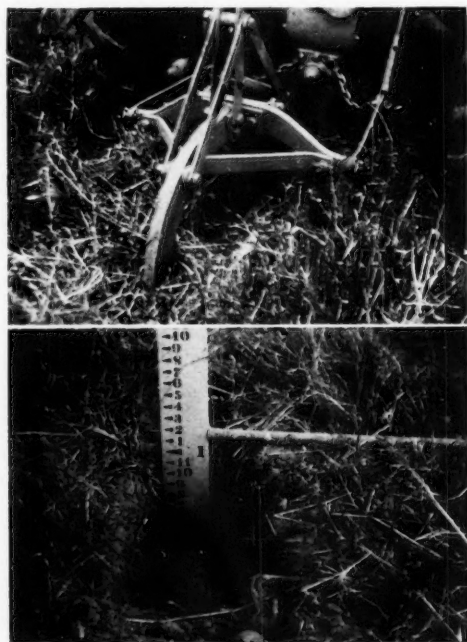


Fig. 4. (Above) Subsoiling with a 2-plow farm tractor during October in a first-year growth of sweet clover. (Below) Penetration secured in the dry soil that had been shattered and deep-limed one year earlier

The deep liming and shattering process was applied to an old bluegrass pasture during the fall of 1948. After plowing and shattering, the surface remained rough until seeded to ladino clover and bromegrass the following April. The new seeding developed sufficiently for grazing by July of that year. Runoff by periods presents a picture of how increased transpiration of soil moisture will favorably modify the rate and amount of surface runoff from these claypan soils.

Shattering and deep liming resulted in the absorption of 1.3 in more rainfall than absorbed by untreated bluegrass pasture from the time of shattering in September to the end of 1948. This resulted in near saturation, and with the soil moisture loss limited to evaporation and the extremely slow percolation into the subsoil, runoff slightly exceeded that on the bluegrass during the remainder of the winter and spring before seeding. As the new seeding developed, runoff became less in rate and amount on the treated pasture. For the period after grazing began in early July to the end of the year, runoff was 62 per cent of that from the bluegrass pasture. It was 76 per cent during 1950, when rainfall was only two-thirds the normal amount and runoff was confined to the first half of the year.

Two terrace outlets were established in *alta fescue* during the fall of 1948 by the deep liming and shattering process. Both were ready to carry runoff from terraces by the following June, about 8 months after seeding. The grass on these outlets is of exceptionally high quality, as shown in Fig. 2.

Two terrace areas were deeply limed and shattered during the fall of 1949. For these larger field areas it was necessary to assemble equipment to do all phases of the process by machinery, as shown in Fig. 3. A 16-in sulky plow was used for the initial 9-in depth of plowing. A dump truck with a lime spreader for a metering device was used to place the lime at the desired rate in the bottom of the furrow. A 16-in scarifier with only one shank, which was equipped with a reinforced garden lister share, was operated in the bottom of the plow furrow to accomplish the shattering and mixing of the lime into the 9- to 16-in zone.

The first runoff records from these areas were secured in 1950, when more than 80 percent of the total runoff for the year occurred during the period January through March, before the treatments had a chance to materially affect crop growth. Runoff differences during this period were not significant. Small reductions were indicated by runoff measurements from rains early in 1951. Records covering a period of several years will be required for conclusive results.

A part of the deeply treated area in sweet clover received a mechanical subsoil treatment last fall. This was done with a subsoiler operated from the hydraulic unit of a two-plow farm tractor (Fig. 4). The operation formed a contour slit or opening into a subsurface furrow for water storage 10 to 12 in below the surface (Fig. 4). The effectiveness of these furrows in improving air and water movement in the soil was observed during April when plowing sweet clover under for corn planting. This area dried somewhat more quickly than the remainder of the shattered and deeply limed area, which, in turn, had dried more quickly than the comparable area without the original shattering and deep liming. A similar observation was made earlier in the spring on the areas drilled to oats. These observations will, of course, need to be confirmed during future spring planting seasons. Subsoiling, or any practice that will speed drying of these claypan soils, that are normally wet and slow to warm in the spring, will increase in popularity with farmers, particularly if it can be practically applied and has yield advantages.

CONCLUSIONS

Subsoiling may be expected to produce moderate increases in crop yields on claypan soils as the Putnam. The important requirements are (a) subsoiling when the subsoil has been dehydrated such that it will shatter, and (b) a deep treatment of lime in the range of 3 to 5 tons per acre. Soybeans have been more responsive to the treatment than other grain crops.

The shattering process dilutes the surface soil with less fertile subsoil. Soil fertility treatments and the growing of deep-rooted legumes such as sweet clover may be expected to

increase the organic matter content of the treated zone of the subsoil by virtue of the deeper rooting induced by the treatment. It is a process that will require more than a few years time for maximum yield increases.

Early measurements indicate that the process will reduce volume and rate of runoff. This is attributed to the increased total space for water storage created in the soil, and the greater available storage volume resulting from increased plant transpiration rates.

The process has possible flood control benefits for these soils that normally produce large amounts of runoff.

Speedier drying of the soil, which allowed field work to begin a few days earlier, was observed during April, 1951, following a period of excess rainfall.

There is indication that the relatively large increase in temporary storage resulting from the mechanical treatment may be effective throughout a sufficiently long period of time for reestablishment of new pasture mixtures and thus eliminate most of the rill and gully erosion experienced when worn out pastures on sloping lands are plowed for retreatment and establishment of the new seeding without terracing. The maintenance of a surface mulch and contour operation of the subsoiler would, of course, be necessary phases of such work.

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were damaged in this field. A comparable field sprayed three times with DT showed an average of 23 per cent of the harvestable ears damaged.

3 Two new types of light traps were tested against corn borer moths in 1950. One was a suction type in which the moths were collected in a basket. The other was a heat-type trap which utilized an incandescent bulb and a heating element. They both have the advantage, in experimental work, of catching the moths intact so that they can be counted.

4 High-intensity lights (2000-w mercury vapor) attracted many moths, but no satisfactory method of destroying the moths so concentrated was found. Lights of the adjacent traps failed to compete with the high-intensity light source.

5 No serious electrical or mechanical difficulties were encountered in operating the light traps, aside from the clogging of the grids.

6 Higher voltage and current output traps, using 6000-v, 12-ma transformers, appeared to solve the plugging problem experienced with low-voltage transformers. However, moth flights were relatively light in 1950 and trouble may be experienced under heavy flight conditions.

7 One-half-inch grid spacing, with $\frac{3}{4}$ -in clearance between grids, appears to be the most satisfactory spacing so far tested.

8 Present types of electrocuting-type light traps are not recommended for commercial control of the corn borer. So far they have not resulted in worth-while reductions of borer infestations.

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Measuring Water-Application Efficiency of Irrigation

By D. K. Fuhrman

MEMBER A.S.A.E.

WATER application efficiency has been defined by Israelsen (11)* as "the ratio of the amount of water that is stored by the irrigator in the soil root zone and ultimately consumed (transpired or evaporated or both) to the amount of water delivered to the farm."

A number of investigations of water application efficiency have been made at various locations in western United States. All of these investigations have used the same basic method of computing water application efficiency. Soil samples have been taken a short time before irrigation, and again shortly after the application of the irrigation water, as a means of evaluating the net gain of water accounted for in the root zone of the crop due to the irrigation. In most of this work investigators undoubtedly assumed that the amounts of water transpired by the crop and evaporated from the soil (a combined use usually designated as consumptive use) during the interval between soil moisture samples would be negligible in comparison with the amount accounted for by the moisture samples. Early investigators (1) included a slight graphically determined correction.

This report presents data which indicate that, in many cases under actual field measurement of water application efficiencies, the amount of water consumed by the crop in the time interval between samples is not negligible and may have a great effect upon the computed efficiency.

The field studies upon which these findings are based were conducted on the south coastal plain of Puerto Rico, but the method of analysis is general and could be applied to similar data collected in any other locality.

DEFINITION OF TERMS

Apparent specific gravity (also known as "volume weight"): The ratio of the oven-dry weight of a given volume of field soil, air space included, to the weight of an equal volume of water.

Available water-holding capacity: The soil moisture storage space represented by the difference between the soil moisture at field capacity and that at the wilting percentage.

Consumptive use (sometimes called "evapotranspiration use"): The sum of the volumes of water used by vegetative growth of a given area in transpiration or building of plant tissue and that evaporated from the soil or plant surfaces, usually expressed in inches of water in a specified time.

Field capacity: The maximum moisture content which a well-drained soil will retain after field saturation against the pull of gravity (usually attained within a few days after irrigation on a cropped soil), expressed as per cent on a weight basis.

Period A: The time interval between the time the "before irrigation" samples were taken and the time irrigation is begun.

Period B: The time interval between the time of beginning

of irrigation and the time the "after irrigation" samples are taken.

Water application efficiency: The ratio of the amount of water stored or accounted for in the root zone to the amount of water delivered to the farm, usually expressed as per cent.

Wilting percentage: The percentage of moisture in the soil at which plants wilt permanently. (May be approximated by determining the moisture in the soil when subjected to a soil moisture tension of about 15 atm.)

REVIEW OF LITERATURE

In California in 1926-27, Beckett et al (1), in connection with a study of water requirements of citrus and avocado trees, made 40 determinations of "irrigation efficiency," a term used by them with the same meaning as "water-application efficiency" as defined above and as used herein but including a slight correction for use by the trees between sampling dates. Other studies of water-application efficiency include 145 determinations by Israelsen et al, in Utah from 1937 to 1941 (12), 14 determinations by Blaney et al, in Pecos Valley, New Mexico, in 1942 (4), and ten determinations by Diebold and Williams in New Mexico in 1948 (10). None of these later investigators made any correction in the basic data to account for consumptive use by the crop in the time interval between the soil samples used to determine the amount of water stored in the soil.

Studies of consumptive use of water have been made on several crops in many locations throughout western United States. Blaney and Criddle, in 1949 (3), reported data which indicated average rates of consumptive use for alfalfa over the entire growing season varying between 0.16 in per day at Bozeman, Montana, and Vernal, Utah, to 0.19 in per day at Carlsbad, New Mexico, and 0.22 in per day at Vale, Oregon. They also computed average rates of consumptive use in the Lower Uncompahgre Valley, Colorado, of 0.13 in per day for corn, potatoes, and sugar beets, and 0.09 in per day for small grains. Studies by Criddle in Boise Valley, Idaho, in 1947 (9), indicate average rates of consumptive use in inches per day of 0.18 for alfalfa, 0.14 for orchards, 0.16 for pasture, 0.18 for sugar beets, 0.16 for potatoes, and 0.17 for corn and small grains. Since these figures in each instance represent average rate of use over the entire growing season, maximum daily rates could be considerably higher than the rates given.

Rates of consumptive use have been found to vary for any given crop with climatic conditions at the site where the crop is grown. In 1916, Briggs and Shantz (7, 8) reported the results of extensive tank experiments on transpiration by growing plants. Their work indicated a relationship between transpiration and rate of evaporation, air temperature, solar radiation, and relative humidity. Blaney and Morin in 1942 (5) proposed an empirical formula for estimating consumptive use of water. Their formula relates consumptive use to temperature, daytime hours, and relative humidity. In 1947, Blaney and Criddle (2) presented a simplification of the Blaney-Morin formula, eliminating the humidity factor.

The rate of transpiration of water by growing plants has been investigated with varied results. Veihmeyer and Hendrickson in 1927 (15, 16) indicated that growth rate and rate of water use by the plant are independent of the moisture content of the soil provided the soil is within the range of available moisture between field capacity and wilting percentage. On the other hand, Wadleigh in 1945 (17) reported data indicating that rate of plant use of water is highest when the soil moisture stress is in the low range.

In considering the root zone of sugar cane, the major crop in this study, it was reported by Lee in 1926 (13) that in a root distribution experiment on sugar cane 64 per cent of the roots were found in the upper 8 in of soil. Less than 10 per cent were found in the third foot. Estimates of root development in one of the study fields of this report were made on an

This paper was taken from a thesis, entitled "Greater Accuracy in Water Application Efficiency Determinations Through a Consumptive-Use Correction Factor," submitted by the author in partial fulfillment of the requirements for the degree of master of science in civil engineering at Utah State Agricultural College, 1950. The work reported is part of the research program of the project, titled "Erosion Control and Stable Crop Production in Puerto Rico," cooperative among the Soil Conservation Service and the Bureau of Plant Industry, Soils and Agricultural Engineering, USDA, the Puerto Rico Agricultural Experiment Station in Rio Piedras, and Luce and Co., Aquirre, P. R.

The author: D. K. FUHRMAN, formerly agricultural engineer of the project mentioned, now research assistant, civil engineering department, University of Wisconsin, Madison.

ACKNOWLEDGMENT: Appreciation is expressed to the officials of the agencies noted above for permission to use the data reported in this paper, and to Dr. R. M. Smith, project supervisor, for many helpful suggestions.

*Numbers in parentheses refer to the appended references.

occasion when a soil profile was taken. These estimates placed 75 to 80 per cent of the sugar cane roots in the first 12 in of soil. Veihmeyer, in 1927 (16), conducted experiments on soil moisture changes in an uncropped soil. He found that, with the water table at a considerable distance below the land surface, there is little movement of the soil moisture over a long period once the soil has reached field capacity, except in the surface 6 in where evaporation has an effect on the moisture content. This work indicates that in the selection of a root zone depth for any crop growing in a well-drained soil little error would be introduced if the root zone used in calculating volume of soil water were considered to be beyond the actual rooting of the plant. Of course, this assumes that the study field has been carefully selected so that there is no ground water effect or large-scale lateral movement of soil moisture.

METHOD OF COMPUTING EFFICIENCY

The method used in determining water-application efficiency herein is basically the same as that used by Israelsen et al, in Utah as reported in 1944 (12), except that a correction factor is introduced to account for the consumptive use by the crop in the interval between the dates of sampling for "before irrigation" and "after irrigation" soil moisture.

As used in this report, water-application efficiency is computed by Israelsen's basic equation:

$$E_a = \frac{d_r}{d_a} \times 100 \quad [1]$$

$$\text{But, as used herein, } d_r = \frac{(P_{w2} - P_{w1}) A_s D}{100} + n_a + n_b \quad [2]$$

$$\text{And } d_a = \frac{Q t}{A} + r \quad [3]$$

$$\text{And therefore } E_a = \frac{\frac{(P_{w2} - P_{w1}) A_s D}{100} + n_a + n_b}{\frac{Q t}{A} + r} \times 100 \quad [4]$$

where A = area of field in acres

A_s = average apparent specific gravity of soil in root zone

D = depth of root zone in inches

d_r = equivalent depth of water accounted for in the crop root zone resulting from the water applied in inches

d_a = depth of water applied by irrigation and rainfall, inches

E_a = water-application efficiency in per cent

P_{w1} = moisture percentage in root zone before irrigation, dry weight basis

P_{w2} = moisture percentage in root zone after irrigation, dry weight basis

Q = discharge of irrigation stream in cubic feet per second

r = rainfall between samples P_{w1} and P_{w2} in inches

t = time required to irrigate field in hours

n_a = consumptive use of water in period A (the interval between the time P_{w1} sample is taken and the time irrigation water is applied) in inches

n_b = consumptive use of water in period B (the interval between the beginning of irrigation and the time P_{w2} sample is taken) in inches.

The difference between the above equation and the one presented by Israelsen (11), on which past studies have been based is the addition of the n_a and n_b terms to the equation above, and the addition of the r term (which is implied but not shown in Israelsen's basic equation). It should be noted that, since n_a and n_b are always positive, the effect of the cor-

rection factor proposed herein is to increase the computed efficiency of water application.

SELECTION OF FIELDS FOR STUDY

This study was conducted on the south coastal plain of the island of Puerto Rico. The fields chosen were carefully selected in order that certain difficulties in collection of field data could be eliminated. The most desirable fields for this type of study are those where (a) the groundwater table is not near enough to the land surface to contribute appreciably to the water used by the crop; (b) facilities are available for accurate measurement of water applied to the field; (c) the soil does not contain gravel to hinder soil sampling; (d) conditions represent an average of the general area; and (e) there exists a willingness on the part of the landowners to cooperate in the research. With these considerations in mind a number of fields were chosen for the study. After selection, a topographic map was made of each field in order that the area, slope, and details of the irrigation distribution system could be determined. The methods of distributing water to most of the fields in the irrigated sections of Puerto Rico are very different from those used in the western United States. The primary method of distribution is through a system locally known as the "McLane" system, carrying the name of an engineer from Hawaii who first introduced this method in about 1908. The layout consists of field laterals (called "McLanes") usually running down the slope and spaced about 20 to 50 ft apart. These laterals carry water to the small "basins" which are laid out on zero slope between the laterals. The furrow, in the bottom of which the sugar cane is planted, is wide and deep and constitutes this "basin" into which the water is run. Most of the fields studied used this type of layout, with an average McLane spacing of 40 ft. Others employing slight modifications of the prevailing system, with McLanes being spaced farther apart and the furrows laid out on a slight grade were also studied in order that application methods could be compared and evaluated. All of the fields chosen were provided with accurate water measurement devices.

In this type of study there are certain relatively fixed physical characteristics of the soil of each field which must be measured. The apparent specific gravity is used to convert moisture percentage to a volume of water. The field capacity and wilting percentage set the upper and lower limits of the available water-holding capacity of the soil. These factors were measured or computed by standard methods, and were utilized in computation and analysis.

CONSUMPTIVE-USE CORRECTION FACTOR

Although most of the consumptive use studies mentioned in the reviewed literature were made from the standpoint of consumptive use over a season with a valley or a river system as a unit, it was necessary for those investigators to study in detail the effect of various crops on the total use. Their objective was the determination of water requirements over a large area, usually for the purpose of water-supply development or conservation. Still, for comparison their data can be reduced to a unit use over a specified period for a given crop. The unit use by different crops can be determined from field plot studies, or tank studies, or a combination of the two. The field plot method, slightly modified by tank studies, was used in the work reported herein.

Average rates of consumptive use were determined from moisture samples over most of one growing season on a number of the fields studied. This was done by calculating the net amount of soil moisture depletion in the period bracketed by the samples. All moisture samples were taken at about the midpoint of the sloping furrow bank with a conventional soil auger. Moisture determinations were made by oven-drying the soil sample. Results of 63 determinations of this type yielded the following average daily rates of consumptive use of water by sugar cane at different growth stages:

*For a detailed explanation of irrigation practices, see "Irrigation Practices in Puerto Rico" by D. K. Fulbright and R. M. Smith. AGRICULTURAL ENGINEERING, January, 1951.

Months after planting	Avg. consumptive use in inches per day	No. of determinations included in average
0-2	0.12	14
2-3	0.15	6
3-4	0.15	8
4-5	0.18	6
5-6	0.19	8
6-7	0.16	2
7-8	0.17	10
8-9	0.14	7
9-10	0.14	2
2 to 10	0.17	49

In the basic data there was some variation in the individual determinations of rate of use, but the trend of the average is quite impressive. One would expect that the rate of consumptive use during early growth stages would be less than the rate when the plant roots and tops have developed more. The pronounced decrease in rate of use as the cane nears maturity, though not so definite as the early increase in rate, may be unexpected to some. The order of accuracy of the water-application efficiency data and of the individual measurements of consumptive use did not seem to justify refinement of the consumptive use correction by using a different rate for each month of crop growth. However, at least the low rate of use in the early stage of growth should be recognized. Therefore, two different use rates have been used: a rate of 0.12 in per day for the first two months of the growth period and 0.17 in per day thereafter, notwithstanding the fact that the rate of use actually varies somewhat over each of these two arbitrary periods.

It would be possible to compute an approximate seasonal consumptive use using the formula proposed by Blaney and Criddle (2), if the "consumptive use coefficient" were known. However, no prior detailed studies have been made for consumptive use of water by sugar cane.

The figures presented above represent average rates of consumptive use over periods in which the soil was usually quite wet at the beginning and considerably drier at the end of the period. Since there is increased evaporation opportunity and the plants may obtain water easier when the soil is wet, the rate of evapotranspiration use is greater when the soil is wet than when it is dry. It was not possible, from the data reported here, to determine whether the theory of Veihmeyer and Hendrickson (15, 16), or of Wadleigh (17), regarding variation of rate of water use by plants with moisture stress changes within the available moisture range, is correct. The problem here was to determine the rates of consumptive use immediately before irrigation, when the soil was quite dry, and immediately after irrigation, when the soil was very wet. In order to evaluate these different rates, sugar cane was grown in twelve large, double-walled "lysimeter" tanks similar to those used by Blaney and Criddle (3, 4) under carefully controlled moisture conditions.

The moisture range in the tank soils was controlled and measured daily by tensiometers as described by Richards (14) and nylon resistance blocks as described by Bouyoucos (6).

Measurements over a two-month period, with sugar cane three to four months old growing in the tanks under four different levels of moisture within the available range, were used to calculate total water consumed (evaporated and transpired). For all tanks an average use of 0.25 in per day was noted, with wet tanks using 17.9 in over the two-month period and the "dry" using 11.8 in. It will be noted that consumptive use in the tanks was somewhat higher than under field conditions. This is consistent with the findings of other investigators (3, 4). Since the tank data are used here only to give relative rates, this difference does not introduce any error. From these data, it appeared that the approximate rate of use just after irrigation in the field is 120 per cent and just before irrigation is 80 per cent of average. Applying these proportions to the basic rates determined from the field

studies, the following average daily rates of consumptive use are obtained:

Sugar cane up to two months old:

Rate just before irrigation (0.12×0.80)—0.10 in per day

Rate just after irrigation (0.12×1.20)—0.14 in per day.

Sugar cane over two months old:

Rate just before irrigation (0.17×0.80)—0.14 in per day

Rate just after irrigation (0.17×1.20)—0.20 in per day.

These figures represent the basic correction factors applied to the water-application efficiency determinations with average consumptive-use rates being determined in the field and the proportional correction for wet and dry soil conditions being determined by lysimeters.

Most of the determinations of efficiency reported here were conducted on sugar cane fields. However, a few were conducted on fields where merker grass was grown. Merker grass, otherwise known as Napier grass, (*Pennisetum purpureum*), is a tall grass quite similar in foliage to sugar cane. Total yields up to 12 tons of dry or 50 tons of green matter per acre are obtained in the field, which is comparable to sugar-cane yields. For these reasons, in the absence of data regarding merker grass, the consumptive use is assumed to be about the same and the same correction factors are used for both crops.

WATER-APPLICATION-EFFICIENCY DETERMINATIONS

A total of 114 separate determinations of water-application efficiency were made on the 19 fields included in the study. Computed water-application efficiencies varied from 9 to 120 per cent, with 9 of the 114 measurements yielding efficiencies slightly greater than 100 per cent, which is physically impossible. Eight of these were obtained on fields where the water was applied by sprinkling, and therefore an application of only about one inch was used. It is easy to see that a small error in any one of the factors could result in considerable error where the depth of water applied is small. For example, periods A and B represented a total of three days in test number 84. The consumptive-use correction factor, then, is 0.60 in, and only 0.90 in of water was applied. If there was an error of as much as 0.10 in in either the consumptive use factor, the soil moisture as determined by sampling (which assumes even distribution), or in the rainfall (which is measured about two miles away), the efficiency might have been 85 per cent instead of the computed 96.

Therefore, the computation of efficiency greater than 100 per cent does not detract from the value of the consumptive-use correction factor proposed herein. Rather, it emphasizes the importance of greater accuracy in the measurement of factors involved any time that the depth of application is small. In fact, it is probable that, for fields where the amount of water applied is small, the experimental errors in measuring the soil-moisture percentage, or the consumptive-use correction factor, are of such magnitude in comparison with the water applied that measurement of water-application efficiency by present methods is unjustified. Actually, we know from the physical situation in these instances that the efficiency is likely to be high unless an unusual situation occurs, and data included herein obtained on these fields serve primarily to emphasize the need for correction to the basic data to account for water consumed.

When low efficiencies were attained, the amount of water applied was usually far in excess of the water-holding capacity—either because irrigation was begun when the soil moisture was already at a high level, or the amount applied was larger than the soil in the root zone could possibly hold. These observations are in harmony with those of Israelsen and colleagues in the Utah work (12).

As already mentioned, the efficiencies obtained under sprinkler irrigation are generally high, with many approaching 100 per cent. Actually this is as one would expect because of the small amount of water applied and the uniformity of distribution if there is no wind when the water is applied.

The prevailing McLane method of water distribution was found quite efficient under optimum conditions, but many instances of low efficiency were also found, and labor costs

¹The studies of consumptive use were continued beyond the stage reported in the thesis. A complete report of this study is in preparation and will include details of the relation of rate of use to stage of growth and other factors. Publication is contemplated at a later date.

Table 1. Summary of a Part of Calculations Showing Effect of the Consumptive Use Correction Factor on the Computed Water Application Efficiency*

1	2	3	4	5	6	7	8	9	10	
Test Number	Measured Soil Moisture Difference Based Upon Soil Samples (Inches)	Period A (Days)	Period B (Days)	Total Estimated Consumptive Use by Crop in Periods A & B (Inches)	Net Water Use and Storage from Water Applied (Inches)	Total Water Applied (Acres-Inches per Acre)	Water Application Efficiency Computed Without Correction	Water Application Efficiency Computed With Correction	Error in Water Application Efficiency if Correction is Not Applied	
4	0.42	1 1/2	1 1/2	0.51	0.93	2.74	15	34	19	
8	1.25	2	1	0.48	1.73	3.78	33	46	13	
12	0.42	1 1/2	1 1/2	0.36	0.78	4.68	9	16	7	
16	2.70	2	2	1.08	3.78	4.56	56	78	22	
20	2.66	2	2	0.68	3.34	5.00	53	67	14	
24	1.61	2	3	0.88	2.59	5.56	29	47	18	
28	0.24	3	1	0.62	0.86	5.73	4	15	11	
32	1.69	3	3	1.02	2.71	14.77	11	18	7	
36	0.38	2	2	0.48	0.86	1.63	23	53	30	
40	1.04	1 1/2	1 1/2	0.51	1.55	2.91	35	53	18	
44	1.32	2	4	1.08	2.60	4.84	27	50	23	
48	2.30	1	1	0.34	2.64	3.06	75	86	11	
52	1.58	2	4	1.08	2.66	3.83	43	70	27	
56	2.15	1 1/2	2 1/2	0.71	2.86	4.08	33	57	24	
60	1.56	1	1	0.34	1.80	5.02	31	36	5	
64	1.70	3	1	0.62	2.32	2.59	63	86	23	
68	2.29	5	2	0.78	3.77	4.83	62	78	16	
72	1.73	1	1	0.34	2.07	3.71	47	55	8	
76	0.46	0	1	0.14	0.80	1.28	52	62	10	
80	0.20	0	1	0.20	0.40	0.90	22	44	22	
84	0.26	0	3	0.60	0.86	0.90	29	96	67	
88	0.93	0	1	0.14	1.07	0.99	94	108	14	
92	0.40	0	0	0.17	0.97	0.99	40	58	18	
96	0.03	0	2	0.40	0.43	1.04	3	41	38	
100	0.60	0	2	0.40	1.00	1.00	60	100	40	
104	1.72	0	1	0.20	1.92	1.90	91	101	10	
108	0.59	0	1	0.20	0.79	0.78	76	101	25	
112	3.29	4	2	0.96	4.29	5.27	62	81	19	
Minimum Effect:	113	3.68	2	1	0.48	4.08	26.45	14	15	1
Maximum Effect:	98	0.03	3	2	0.82	0.85	0.90	3	95	92

* In the interest of brevity, only one-fourth of the results given in the thesis are presented here.

using this method would usually be prohibitive in western United States.

EFFECT OF CONSUMPTIVE-USE CORRECTION FACTOR

In order to determine the effect of the consumptive-use correction factor on the water-application efficiency obtained in each test, the efficiency was computed, as in previous work (4, 10, 12), without including the correction, for comparison with the values of efficiency obtained with the correction as reported herein. A summary of these calculations is presented in Table 1. The figures in this table show that the least effect of the correction factor was on test number 113 where it only increased the computed efficiency by one per cent. It is noted that this irrigation was the heaviest of all in the study, the irrigator having applied a total of 26.45 in of water per acre in this one irrigation. The greatest effect was on test number 98 where the computed efficiency was increased from 3 to 95 per cent when the correction factor was included. The greatest effect is noted on those fields where the time lapse in periods A and B was large and the amount of water applied was small. To show the relationship between depth of water application, time lapse in periods A and B, and the error in water-application efficiency due to neglecting consumptive use, Fig. 1 was prepared by plotting for each test the ratio $e/(I_a - I_b)$ (where e is total error in efficiency caused by neglecting the consumptive-use correction factor, and I_a and I_b are the number of days in periods A and B, respectively) against the depth of water applied. The resulting graph shows a very consistent relationship between these factors.

This curve may be used to approximate the error in water-application efficiency if the consumptive-use factor is neglected on studies already completed or to be conducted in the future. It is important to note, however, that application of the curve should be limited to crops whose consumptive use rate under the given site conditions is approximately the same as sugar cane. It is probable that this curve could be applied to studies on sugar beets, small grains, corn, or beans to obtain an approximation of the effect of the consumptive-use

correction factors. An application of the curve can be easily shown by referring to past studies. For example, Israelsen et al (12) report details of many determinations of water application efficiencies. Among detailed measurements on their farm number 8, two tests were made on sugar beets where depths of water application were 2.9 and 4.9 in. If it were determined from their original field notes that, in both tests, four days elapsed in periods A and B combined, the curve shows that the error in efficiency in the case of the 2.9-in application is 5.4 x 4, or about 22 per cent. In the case of the 4.9-in application, the error would be 3.2 x 4, or about 13 per cent. This would result in an increase over their reported values of water-application efficiency from 48 to 70 per cent for the 2.9-in irrigation, and from 37 to 50 per cent for the 4.9-in irrigation.

SUMMARY

1 A correction factor taking into account the consumptive use by the crop in the period between "before irrigation" and "after irrigation" soil moisture samples should be included in computing the net water accounted for in the crop root zone as a result of the irrigation of the field.

2 The consumptive-use correction factor can be approximated by determining rates of soil moisture depletion by the crop.

3 The rate of consumptive use of water varies somewhat with the season of the year, climatic conditions, and stage of crop growth. It is difficult to separate the variables, but there appears to be an appreciable increase in the rate of consumptive use by sugar cane more than two months old as compared with that less than two months old.

4 The average rate of consumptive use of water by sugar cane, as determined by soil-moisture depletion measurements is about 0.12 in per day in the first two months of crop growth and about 0.17 in per day after more than two months growth has been attained.

5 Errors caused by neglecting the consumptive-use factor in water application-efficiency measurements are very large in some cases. The magnitude of error is greatest when the depth of water applied is small and periods A and B extend over several days.

6 Because of the approximate nature of the consumptive-use correction factor, the experimental errors involved in the measurement of average soil moisture for a given field, and errors in the measurement of other factors necessary to a determination of water-application efficiency, it is impossible to determine efficiency with accuracy when the amount of water applied is about one inch depth or less. However, in spite of this, the efficiency can be computed with greater relative accuracy in any case than is possible if the consumptive-use factor is neglected.

(Continued on page 454)

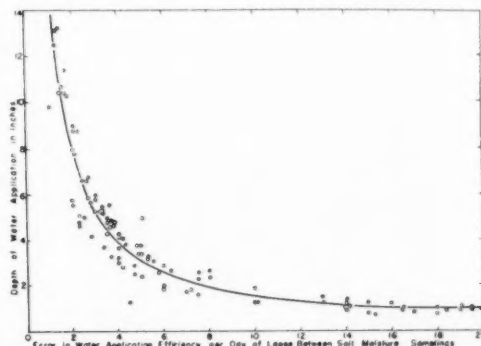


Fig. 1 Relationship between depth of water application, days lapse between samples before and after irrigation, and error in the computation of water application efficiency percentage if consumptive use factor is neglected. (Data based on 114 determinations of efficiency on sugar cane and meadow grass)

NEWS SECTION

ASAE Annual Meeting in Texas a Success

THE 1951 (44th) annual meeting of the American Society of Agricultural Engineers held at the Rice Hotel in Houston, Texas, will rank with the best of these yearly events held since the founding of the Society in 1907. The official host of this year's meeting was the Society's Southwest Section, which geographically is comprised of the states of Arkansas, Louisiana, Oklahoma, and Texas. The Committee on Local Arrangements was made up mainly of Texas members of ASAE, from College Station and Houston, with Fred R. Jones, head of the agricultural engineering department, A. & M. College of Texas, as general chairman. The gracious hospitality of the hosts was one of the heart-warming features of the meeting.

The official record of attendance at the meeting in Houston showed a total in excess of 500. This included a registered attendance of nearly 400, and in addition nearly 100 women and children. Though this attendance was less than that of annual meetings in recent years, it was regarded as good, all things considered.

The meeting began to get under way with sessions of the Council and Cabinet on Sunday forenoon and afternoon, June 17. Those attending the meeting began arriving in force in the afternoon, and the registration desk was an active center the remainder of the day. Early arrivals were entertained Sunday evening by illustrated talks of outstanding excellence given by Mr. and Mrs. Harris P. Smith of College Station, based on a year they had previously spent in Turkey, together with a trip to the Holy Land.

The meeting officially opened with four concurrent programs, arranged by the Society's Power and Machinery, Rural and Electric, Farm Structures, and Soil and Water Divisions, which occupied the period of Monday forenoon, June 18.

The first general session of the meeting was held at 2 p.m. on June 18, and was opened by F. R. Jones, chairman of the Committee on Arrangements, who introduced E. W. Schroeder, who as general chairman of the 1950-51 Meetings Committee had general charge of arranging the program. Mr. Schroeder spoke briefly of the program, and, also in his capacity as chairman of the Society's Southwest Section, he extended a welcome to the group on behalf of the host section.

Arrangements Chairman Jones then introduced Society President Fred C. Fenton, head, agricultural engineering department, Kansas State College, who delivered the president's address, entitled "Agricultural Engineering in a Period of Confusion," appearing elsewhere in this issue.

At the conclusion of his address, President Fenton introduced Louis P. Merrill, regional director, Western Gulf Region, U.S. Soil Conservation Service, whose excellent address was devoted largely to the more outstanding accomplishments of agricultural engineers in dealing with the soil and water conservation problems in the Western Gulf Region.

The general session was followed by the Society's annual business meeting which included a resume of the annual report of the Secretary-Treasurer and reports by the chairmen of several committees including the Committee on Defense Activities (F. P. Hanson), Committee on Agricultural Processing (S. M. Henderson), Committee on Extension

A.S.A.E. Meetings Calendar

- August 27-29—NORTH ATLANTIC SECTION, Chalfonte-Haddon Hall, Atlantic City, N. J.
- October 18 and 19—PENNSYLVANIA SECTION, William Penn Hotel, Pittsburgh, Pa.
- October 25-27—PACIFIC NORTHWEST SECTION, Pullman, Wash., and Moscow, Ida.
- October 27—OHIO SECTION, Ives Hall, Ohio State University, Columbus
- December 17-19—WINTER MEETING, The Stevens, Chicago, Ill.
- February 4-6—SOUTHEAST SECTION, Atlanta Biltmore Hotel, Atlanta, Ga.
- June 16-18—ANNUAL MEETING, Hotel Muehlebach, Kansas City, Mo.

Note: Information on the above meetings, including copies of programs, etc., will be sent on request to A.S.A.E., St. Joseph, Michigan

(L. G. Samsel), Committee on ASAE History (J. B. Davidson), and Committee on Public Relations (Charles E. Ball). As a member and official representative of the Mid-Central Section of the Society, President Fenton extended a cordial invitation to all present to attend the Society's 1952 annual meeting to be held in Kansas City. Also, B. P. Hess, representing ASAE members in the area of Pittsburgh, Pa., painted an interesting picture of the many attractions offered by Pittsburgh as a place for holding an annual meeting of the Society; he closed by stating that an invitation to hold the meeting there in 1953 was to be presented to the Council for consideration.

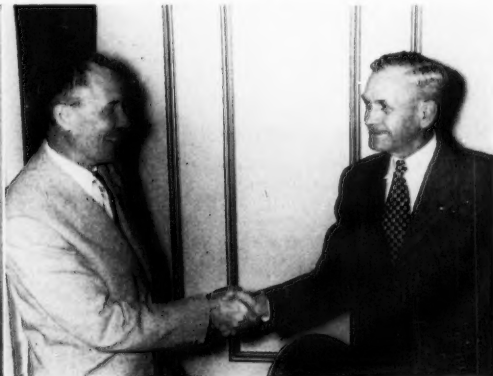
About 40 members of student branches of the Society from various parts of the country were registered at the meeting, and as usual, since 1939, the high point of attraction for the student group (perhaps excepting the "Melody Maids") was the complimentary dinner given to members and faculty advisers of student branches of ASAE in attendance of the meeting by the International Harvester Company. Following the dinner the students had the privilege of listening to short talks by President F. C. Fenton and President-Elect Stanley Madill and by an illustrated talk of particular agricultural engineering interest on the Hawaiian Islands by Dr. E. G. McKibben, formerly head of the agricultural engineering department of the Pineapple Research Institute of Hawaii and presently in charge of the USDA Tillage Machinery Laboratory of Auburn, Ala.

Two other programs arranged for the evening of June 18 included one sponsored by the Committee on Extension and the other by the College Division, the general theme of the latter being objectives and content of agricultural engineering courses.

The forenoon of the second day, Tuesday, June 19, was given over to four concurrent programs of the Power and Machinery, Rural Electric, Farm Structures and Soil and Water Divisions.



(Left) At the 1951 ASAE annual dinner at Houston, Tex., June 20, Society President Fred C. Fenton (left) is shown here awarding the Farm Equipment Institute trophy to a representative—Kenneth A. Jordan—of the Purdue Student Branch of ASAE. The Purdue Branch



was the 1951 winner, over 22 other Branches, of the FEI award. (Right) Incoming ASAE President Stanley Madill (left) is installed in the top Society office by the outgoing president, Fred C. Fenton (right), at the close of the Society's annual dinner on June 20



The 1951 ASAE gold medal awards were awarded to recipients at the Society's annual dinner at Houston, Tex., June 20. President Fred C. Fenton is shown here awarding the John Deere Medal to Charles N. Stone (on the right in the left-hand view), vice-president in charge of

product development, Deere & Co. — and the Cyrus Hall McCormick Medal to Charles E. Seitz (on the left in the right-hand view), head, agricultural engineering department, Virginia Polytechnic Institute. The awards were for outstanding engineering achievement.

The early part of the afternoon of June 19 was devoted to a special agricultural aviation program arranged by the Society's Committee on Agricultural Aviation. Following this program, the group was transported by busses and private cars to R. E. Smith's ranch outside of Houston for a field demonstration of agricultural aviation, including a new specially designed plane for agricultural use developed in connection with the cooperative agricultural aviation research project at the A. & M. College of Texas. Following the demonstration, the convention group including ladies and children partook of a typical Texas barbecue at the Smith ranch.

Three concurrent programs were the order of the day for the forenoon of Wednesday, June 20. These included programs sponsored by each of the Power and Machinery and Soil and Water Divisions and a joint program arranged by the Farm Structures and Rural Electric Divisions.

The afternoon of Wednesday, June 20, was devoted to a program arranged by the College Division and of particular interest to all agricultural engineers. The program opened with an interesting talk on the placement of college graduates by the director of placement and personnel of A. & M. College of Texas, which was followed by a panel discussion on employment requirements of agricultural engineering graduates.

Always the climatic event of any ASAE annual meeting, the annual dinner of the Society was held Wednesday evening, June 20, in the Crystal Ball Room of the Rice Hotel. This event was presided over by E. W. Schroeder as master of ceremonies.

At the close of the dinner, Mr. Schroeder introduced President Fenton who presented the various Society awards usually made on this occasion. This included the award of the 1951 John Deere gold medal to Charles N. Stone, vice-president in charge of product development of Deere and Company and the Cyrus Hall McCormick gold medal to Charles E. Seitz, head, agricultural engineering department, Virginia Polytechnic Institute. He also made the formal award of the Farm Equipment Institute trophy for 1951 to the Purdue Student Branch of the Society which placed first among the 23 student branches which competed for the award. Other awards made on the occasion included the five ASAE paper awards and the ASAE Collegiate Awards.

Following the awards, President Fenton introduced Charles T. Evans, vice-president, Arkansas Power & Light Company, Little Rock, as the speaker of the occasion. Mr. Evans address was a happy mixture of good humor and sound sense, and judging from remarks afterwards, it would rate as a fine model for an after-dinner speech.

The last official act of President Fred C. Fenton was the inauguration of the new president of ASAE for the Society year 1951-52, Stanley Madill, executive engineer, John Deere Waterloo Tractor Works of Deere Manufacturing Company, who in receiving the official Society gavel as the symbol of the office of President, in turn complimented Mr. Fenton for his service to the Society during the preceding year, and presented him with the official ASAE past-president emblem.

Two entertainment numbers concluded the dinner program, and was followed by dancing until midnight.



(Left) Fred R. Jones (at mike), general chairman, Local Arrangements Committee, 1951 ASAE Annual Meeting, makes some final announcements at the Society's annual dinner on June 20. Seated (at left) Mrs. E. W. Schroeder and E. W. Schroeder, master of ceremonies at the

annual dinner, as well as general chairman of the 1950-51 ASAE Meetings Committee. • (Right) New ASAE President Stanley Madill sounds progressive keynote for ensuing year of Society activities, as he takes office at the close of the 1951 annual dinner

Virginia Section Elects Waller

J. A. Waller, Jr., associate agricultural extension engineer, Virginia Polytechnic Institute, was elected chairman of the Virginia Section of the American Society of Agricultural Engineers at the annual Section meeting held in Roanoke on May 11 and 12. He succeeds V. R. Hillman, executive officer, Virginia State Soil Conservation Committee.

At the same meeting the Section also elected three vice-chairmen: J. L. Calhoun, associate extension agricultural engineer, VPI; U. F. Earp, agricultural engineering department, VPI; and M. M. Johns, manager, farm supply services, Southern States Cooperative. McNeil Marshall, associate agricultural engineer, Virginia Agricultural Experiment Station, was elected the new secretary-treasurer of the Section.

The meeting opened at 2:00 p.m. on May 11 with Roy B. Davis, Jr., presiding and following opening remarks by V. R. Hillman, Section chairman, the subject of opportunities for agricultural engineers in foreign service was presented by A. G. Kevorkian, Office of Foreign Agricultural Relations, USDA. J. Dewey Long, a past-president of the ASAE, and special assistant, Divisions of Agricultural Engineering, USDA, was the next speaker who talked on the benefits to ASAE members from participation in state and national activities of the Society. A technical paper on the design and management of driers of baled hay was presented by V. H. Baker of the Virginia Agricultural Experiment Station. The closing number on the program was a report on the activities of the Virginia Student Branch of ASAE made by the branch president, R. S. Gay.

Mr. J. A. Waller, Jr., presided as toastmaster at the annual Section dinner in the evening. The speaker for the occasion was Edwin C. Marsh, business administration department, VPI, who related his experiences abroad during World War II.

R. J. Blair, vice-chairman of the Section, presided at the forenoon session on May 12. The first speaker, E. O. Gardner, Jr., International Harvester Co., discussed the application of the hydraulic lift to modern farm equipment. This was followed by a talk on land-use practices as they relate to soil hydrology by Marvin D. Hoover, branch manager, Central Piedmont Research Center of the USDA Forest Service. The closing number on the program was a panel discussion by four VPI agricultural engineers, J. H. Lillard, E. T. Swink, J. A. Waller, and G. D. Kite on the subject "Agricultural Engineering in Virginia's Changing Agriculture."

Penn State's A-E Alumni-Student-Staff Dinner

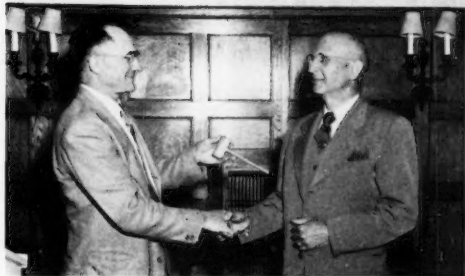
IN APRIL of 1946 the agricultural engineering department at Pennsylvania State College held its first alumni-student-staff dinner. Seventy-four persons were present. Everyone seemed so well pleased with the idea and had such a good time, the group voted unanimously to make the occasion an annual affair. In fact, the dinner has now become a Penn State tradition.

At the first dinner, the dean of agriculture of the College was the speaker. Dr. Lyman E. Jackson had been recently appointed dean, and the alumni wanted to meet him. Also, a representative of the president's office spoke regarding College affairs.

At another one of these dinners, a group of the alumni spoke briefly about the work in which they were individually engaged. This was greatly appreciated by the students who so often wonder what agricultural engineers do after graduation. On another occasion the program consisted of brief talks by the directors of research, instruction and extension at the College. And still another occasion the talks were given by members of the agricultural engineering staff.

On none of these occasions have outside speakers been brought in for formal addresses. It is our thought that there is ample talent among our staff, student, alumni, and college administration personnel for many years to come. After all, it is an intimate group of people who like short, snappy programs, a good dinner, and then an opportunity to renew old acquaintances and to make new ones.

An effort is made for members of our ASAE Student Branch to derive as much benefit from these annual occasions as possible. The Branch appoints a committee to help with



In this picture retiring chairman, V. R. Hillman of the Virginia Section of ASAE is installing J. A. Waller, Jr., as the new Section chairman for 1951-52.

the preparations, and the president of the Student Branch is usually the master of ceremonies. A member of the staff always handles correspondence with the alumni for the purpose of keeping the addresses of the alumni up to date, inviting them to the dinner, telling them about the program, etc.

Prior to the dinner, an alumni directory is prepared, a copy of which is placed at each plate together with a copy of the dinner program and a list of all agricultural engineering students, by classes. At the dinner, as a rule, each student and alumnus introduces himself.

Every effort is made to have a brief, snappy program so that those attending will want to return the next year. As a rule the dinner is held on Saturday evening. In this way the alumni have Saturday afternoon to reach the College and Sunday to return home. Often the Student Branch holds a tea Saturday afternoon from 3:30 to 5:00 p.m. which gives the alumni a place to go on arrival on the campus.

At our dinner this year the program was a little different. Dr. Milton S. Eisenhower, president of the College, had agreed to speak to the group. So we invited the ASAE Pennsylvania Section to join us at the dinner. This increased our attendance to 147. These dinners have been well attended and have resulted in bringing students, alumni, and staff members closer together. Former graduates are now returning to employ graduating seniors and offering summer employment to undergraduates.—R. U. Blasingame, head, agricultural engineering department, Pennsylvania State College.

ASAE Southeast Section Meeting, February 4-6

ANNOUNCEMENT is received of selection of dates and place for holding the yearly meeting of the Southeast Section of the American Society of Agricultural Engineers, the area of which comprises roughly the states east of the Mississippi and south of the Ohio and Potomac Rivers, except West Virginia. The meeting will be held at Atlanta, Ga., February 4 to 6, 1952, with the Atlanta Biltmore Hotel as meeting headquarters.

(Continued on page 438)



This picture was taken at one of the agricultural-engineering, alumni-student-staff dinners at Pennsylvania State College, which R. U. Blasingame tells about on this page.

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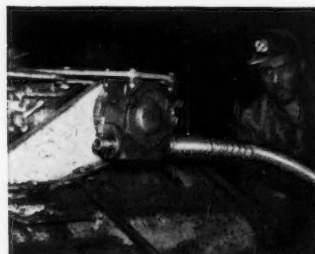
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NEWS SECTION (Continued from page 436)

As usual in recent years, the meeting will be held in conjunction with the annual convention of Association of Southern Agricultural Workers.

Southeast Section officers for the current year are: chairman, F. A. Kummer, head, agricultural engineering dept., Alabama Polytechnic Institute, Auburn; first vice-chairman, E. T. Swink, associate professor of agricultural engineering, Virginia Polytechnic Institute, Blacksburg; second vice-chairman, S. C. Smith, regional product specialist, International Harvester Co., Memphis, Tenn., and secretary, G. H. Dunkelburg, associate agricultural engineer, South Carolina Agricultural Experiment Station, Clemson.

Marker for Original Mangum Terrace

UNVEILING exercises were held on May 7 to celebrate the marking of the first broad-base terrace built in the United States.

The inscription on the marker reads "Mangum Terrace—Early erosion-checking terrace constructed by Priestley H. Mangum about 1885, widely copied in other parts of the U.S."

Distinguished guests present for the occasion were P. H. Mangum III, son of the inventor of the terrace, who unveiled the marker; Dr. Clarence Poe, editor, *The Progressive Farmer*, and representatives of North Carolina State College, including Dr. J. H. Hilton, dean of agriculture; D. S. Weaver, director of agricultural extension; G. W. Giles, head agricultural engineering department, and H. M. Ellis, in charge of agricultural engineering extension.

The marker is located near the terrace in Wake County, near Wake Forest, N. C. Historical significance of the terrace is indicated, not only by the wide extent to which the design has been used throughout the United States and other parts of the world, but also by the fact that the original terrace is still functioning properly after 65 years.

Credit for initiating the project to appropriately mark this historic site goes to the Student Branch of the American Society of Agricultural Engineers at North Carolina State College, under the leadership of the Branch's faculty adviser, N. C. Teter. The Branch, in 1950, considered the idea, appointed a committee, and enlisted the cooperation of the College's department of archives and history. Officers of the Branch at that time were Jack Traywick, president; David Moore, vice-president; J. A. Miller, secretary; J. H. McBrayer, treasurer; and Zane Blevins, committee chairman. The Branch, the agricultural engineering department, and the department of archives and history jointly sponsored the unveiling exercises.

Nominations for 1952 ASAE Medal Awards

IN ACCORD with the rules governing the award of the John Deere and Cyrus Hall McCormick Gold Medals, the Jury of Awards of the American Society of Agricultural Engineers will receive from members of the Society, up to November 1, nomination of candidates for the 1952 awards of those two medals.

Members of the Society nominating candidates for either award are requested to keep in mind the purposes of each medal and make their nominations accordingly. The John Deere Medal is awarded for "distinguished achievement in the application of science and art to the soil," which citation is interpreted to cover more than a mechanistic concept of engineering, and to include chemistry, physics, biology, and any other science and art involving the soil, the "application" being acceptable to "evaluation by the engineering criteria of practicality and economic advantage."

(Continued on page 440)

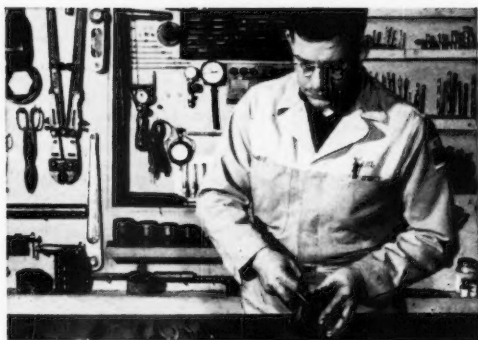


This marker, commemorating the first (Mangum) broad-base terrace built in the United States, was initiated by this group of members of the North Carolina Student Branch of ASAE at North Carolina State College

A report to you about men and machines that help maintain International Harvester leadership

IH Dealers Give Fast Service

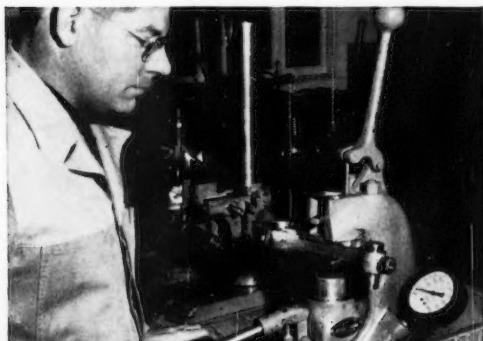
IH Trained Servicemen Use Precision Equipment to do Blue Ribbon Quality Work . . . to shorten overhaul time



The right tools in the right hands reduce guesswork and reworking. IH trained servicemen use delicate instruments to quickly diagnose trouble . . . precision tools to correct it. Micrometers and feeler gauges magnify the sensitivity of skilled hands . . . grade the precision of their work in thousandths of an inch. IH approved tools and equipment, in experienced hands, duplicate factory workmanship . . . make overhauled tractors and farm implements act like new again.



Taking the pulse of a tractor engine with an electronic tachometer quickly reveals whether it is delivering the rated rpm. If the reading isn't up to par, IH trained servicemen immediately check the governor adjustment . . . look for a weak spring or worn linkage. This speed counter is typical of the modern testing equipment IH servicemen use. Because it lets servicemen spend less time detecting and more time doctoring, farmers get better service at lower cost.



Making a crooked rod go straight is mighty important. Slight bends or twists in a connecting rod, that escape the naked eye, cause excessive piston wear. IH servicemen use an aligner to check the trueness of connecting rods . . . straighten them within factory limits. Tools like these help explain why IH 5-Star Service, offered by International Harvester dealers, restores like-new performance to worn farm equipment.



Little things make IH service lots better. Take the tightening of bolts, for example. IH servicemen use torque wrenches to tighten cylinder heads, connecting rods, and main bearings. This prevents distortion, caused by uneven tightening, which can soon ruin an engine. IH servicemen double check their work with feeler gauges and micrometers—take pains with the smallest detail because they take pride in doing every job right.



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International Harvester products pay for themselves in use—McCormick Farm Equipment and Farmall Tractors . . . Motor Trucks . . . Crawler Tractors and Power Units . . . Refrigerators and Freezers—General Office, Chicago 1, Illinois

The Cyrus Hall McCormick Medal is awarded "for exceptional and meritorious engineering achievement in agriculture." Selections for the award may be in recognition of a single item of engineering achievement, but is more likely to be on the basis of the aggregate of weighted accomplishment through a continuing career.

The Jury of Awards desires that members of the Society consider it their duty and obligation to give serious thought to the matter and nominate for either or each of these awards the men they believe to be most worthy of the honor. Each nomination must be accompanied by a statement of the reasons for nominating a candidate and qualifications of the nominee, including his training, experience, contributions to the field of agriculture, a bibliography of his published writings, and any further information which might be useful to the Jury in its deliberations.

The Jury will accept and consider nominations received on or before November 1, and these nominations should be addressed directly to the Secretary of the Society at St. Joseph, Michigan. The Secretary will supply on request a standard set of instructions for preparing informa-

tion in support of nominees for the Society's gold medal awards; in fact, it is important that these instructions be followed in preparing material on behalf of any nominee.

Farm Defense Production Requirements

THE critical materials situation, as related to farm production goals and farm equipment requirements was reviewed in Chicago the evening of July 20 for a group of representatives of the farm equipment industry and the farm and trade press. Three speakers representing various phases of the problem addressed the conference.

Gus L. Geisler, administrator, Production and Marketing Administration, U.S. Department of Agriculture, reviewed present and probable future food and fiber goals and agriculture's requirements for meeting those goals. He indicated that reserve stocks or carryover of many important items are already below normal.

The National Production Authority was represented by Franz T. Stone, II, assistant administrator, and head of its Bureau of Industrial and Agricultural Equipment, who reported on its plans for meeting farm requirements as presented by the U.S. Department of Agriculture.

While indicating a keen appreciation of the importance of farm and farm-equipment production in the defense program, he made it clear that the supply of steel, copper, aluminum and possibly other critical materials would be tight, and that the farm equipment industry would not get all it asks for.

John L. McCaffrey, president of the International Harvester Co., and of the Farm Equipment Institute, spoke for the industry as to allocations of materials and methods of operation which would enable it to handle its part of the job. He pointed out that while the industry is interested in cooperating on the defense program to the fullest extent, what it will be able to do will depend on what materials it can get, and that in order to plan its future operations effectively it must know soon from the NPA, what it can reasonably expect in actual delivery of materials.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

AGARWALA, V. N., P.O. Bairagarh (Bhopal), India

BARKER, JAMES R., Logan, Utah

BARKSTROM, R., East Moline, Ill.

BHATT, B. T., Saurashtra, Junagadh, India

BOWER, WILLIAM R., Cambridge Springs, Pa.

CREWZ, WARREN G., Queen City, Mo.

CURRY, R. BRUCE, Valley Falls, Kans.

DEWAN, B. B., New Pusa, New Delhi, India

DIXON, JOHN E., Fort Collins, Colo.

DUKE, H. L., Havana, Fla.

DUKESHIRE, L. N., Moline, Ill.

FAHR, IRVIN W., Waterloo, Iowa

FLORENCE, DONALD M., East Lansing, Mich.

FRISBIE, BRUCE W., Kingman, Kans.

GILBERT, CREIGHTON N., Casper, Wyo.

GRAHAM, JAMES A., Waterloo, Iowa

HAEGELIN, JOE A., Houston, Tex.

HOFFMAN, LEE S., East Lansing, Mich.

HUFFMAN, ROY T., JR., Los Alamos, N. M.

JACKEL, ERNEST W., Racine, Wis.

LUSCOMBE, JAMES A., College Station, Tex.

MAGEE, ALLAN L., Ottawa, Ont., Canada

MOE, ALLEN J., Norton, Kans.

POPOV, WSEWOLOD, Stuttgart-Sued, Germany

POIK, LESTER M., Wichita Falls, Kans.

PRICE, CHARLES E., Plainfield, Ind.

SIVYER, WILLIAM, Philadelphia, Pa.

STOLLER, JAMES E., Portland, Ore.

WOLFE, HARRY D., Centre Hall, Pa.

WORKS, D. W., Big Sandy, Mont.

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Dependable manpower and dependable horsepower... these make the difference when you're baling hay at peak quality or harvesting crops without delay. And the outstanding feature of air-cooling in Wisconsin Engines is a contributing factor in more horsepower dependability and equipment dependability, too.

Baling and harvest crews work miles from water on hot-test days with no power shutdowns. The Wisconsin Engine cools perfectly even in extremely high temperatures. It never runs out of air. No trips to town either for radiators, pumps, water jackets or extra gears. And since more horsepower works in smaller space, combines and balers and other mechanized farm equipment within a 3 to 30 hp. range can be built more rugged for easier operation without adding extra weight. Manpower does better work faster... adding up to BETTER FARMING at MORE PROFIT.

Complete your power file with "Power Magic"... a booklet telling about 4-cycle single-cylinder, 2-cylinder and V-type 4-cylinder models, 3 to 30 hp.



Single-cylinder,
3 to 6 hp.



Single-cylinder,
6 to 9 hp.



2-cylinder,
7 to 13 hp.



V-type 4-cylinder,
15 to 30 hp.



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Homemade Hydraulic Dump Wagon saves labor at Harvest Time



Hydraulic power operates this novel homemade dump wagon. Louis Zinke (right), prominent farmer near Yoakum, Texas, demonstrates his "corn hopper" as Texaco Man Arno Rudolph looks on. Havoline Motor Oil has kept Mr. Zinke's tractor engine in good condition for 19 years! This great oil outperforms not only Premium but other good heavy duty motor oils.

Despite Texas heat, Marfak lubricant does not melt down or drip off but sticks to bearings, seals out grit and dirt and provides positive lubrication. That's why Mr. Zinke uses Marfak on all his machines, tractor, truck, and car. There's no better lubricant made.



LOUIS ZINKE, who farms 200 acres near Yoakum, Texas, has found new ways to harness gasoline and hydraulic power to eliminate back-breaking, time-consuming labor.

He designed and built the hydraulic-powered dump wagon shown at left. At harvest time a load of corn from the field is dumped onto an elevator which hoists it into the barn.

Mr. Zinke has also developed an effective hydraulic-powered "tree shaker" for his pecan grove. This shakes the pecans off the trees. He then uses a hydraulic scoop to gather the nuts.

Mr. Zinke has discovered that it pays to farm with Texaco Products.



It gets hot and dusty up in Washington too. So keen farmers, like Fred Buscher (left), near Ritzville, say there is nothing like Marfak lubricant. Here Mr. Buscher is shown pumping in some Texaco Universal Gear Lubricant EP, another great Texaco wear saver, as Texaco Man Paul Meyer looks on.



"Corn picker grease"—that's what farmers in the Middle West call Marfak lubricant. Corn pickers put a lubricant through the toughest test of all; that's why leading farmers, like August Schoolman, of Onarga, Illinois, use this famous Texaco lubricant. It stays on the job, seals dirt out.



Mr. George Tinkham (right), successful truck farmer near Cape Charles, Virginia, fills his tank with Fire-Chief, the gasoline with superior "Fire-Power" for low-cost operation. Lance Fulcher and his son-in-law Vernon Martin (left), like Texaco Men the country over, give timely service that farmers appreciate.



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Texaco Petroleum Products are Manufactured and Distributed in Canada by McColl-Frontenac Oil Company Limited.

ASAE North Atlantic Section Program

THE program for the yearly meeting of the North Atlantic Section of the American Society of Agricultural Engineers, to be held August 27 to 29 at Atlantic City, N. J., with headquarters at the Chalfont-Haddon Hall is now in practically final form. Printed copies of the program are being sent to all ASAE members residing in the North Atlantic Section area, and will also be sent to other members of the Society, on request to the ASAE headquarters office, St. Joseph, Mich.

The opening program on Monday forenoon, August 27, will include two addresses, one on the psychology of progress by L. P. Shannon of the DuPont organization and the other on equipment requirements of agriculture for meeting food and fiber goals by Gus L. Geisler, administrator, Production and Marketing Administration, USDA.

Four concurrent programs will be presented during the afternoon of the first day. The farm structures program will be a panel discussion on new developments in coatings for farm use. The specific subjects will be exterior and interior paints, paints for metal, masonry and concrete, application methods, and painting for safety and sanitation. Speakers will be representatives from the DuPont Co., Glidden Co., Lead Industries Assn., and DeVilbiss Co., and Arnold Nicholson, managing editor of *Country Gentleman*.

The power and machinery program will include a paper on valve rotation in tractor and automotive engines by Herbert Sumner, Ethyl Corp.; another paper on farm machinery requirements of grassland farming by C. B. Bender, Rutgers University; and a third paper on recent developments in farm equipment lubrication by N. T. Brenner of Gulf Oil Corp.

The soil and water program will open with a discussion of irrigation research in the Northeast by F. W. Peikert, University of Maine, and will be followed by a paper on the reclamation of tidal marshlands in the maritime provinces by J. S. Parker, Canada Department of Agriculture. E. W. Gain, U.S. Soil Conservation Service, will discuss drainage by the interception method, and T. E. Long, Portland Cement Assn, will give the concluding paper on the construction and use of concrete farm drain tile.

The rural electric program will open with a paper by W. D. Hemker of Westinghouse Electric Corp. and J. S. Perry of Pennsylvania State College on a new control for infrared lamp brooding for chicks. E. B. Webb, Atlantic City Electric Co., will follow with a discussion of new developments in underfloor heat for chick brooding. M. H. Lloyd,

Niagara Mohawk Power Corp., will discuss the tamper-resistant fuse situation, and low-voltage remote control wiring systems will be the subject of a paper by H. H. Watson, General Electric Co.

The Section business meeting will be held the first thing on the second day of the meeting, August 28, and will be followed by a general program, including an address by Dr. Houston Peterson, Rutgers University department of philosophy, on anger, anxiety and animation, and a second address by E. S. Lee, editor of *General Electric Review*, on research and development. These addresses will be followed by a motion picture on farm safety.

The program for Tuesday afternoon, August 28, consists of three concurrent sessions. A joint power and machinery and soil and water program will open with a talk by T. B. Chambers, U.S. Soil Conservation Service, on earth moving for soil conservation structures, and will be followed by a talk on the use of the farmer's own power by R. P. Conway, Gash-Stull Co. J. Irwin Davis, Sr., Caterpillar Tractor Co., will discuss the place for industrial equipment in the soil conservation program, and will be followed by R. R. Poynor, International Harvester Co., who will describe new developments in tillage equipment and methods. A talk on the equipment for seeding the newer grass mixtures will be given by Harrison Weaver, Jr., Brillion Iron Works. "Power for Protection" is the title of a motion picture film, made by Caterpillar Tractor Co., which will conclude the program of this session.

The farm structures program will open with a paper on potato storages by R. S. Claycomb, USDA, agricultural engineer, and the remainder of the session will be devoted to a panel discussion of the new things in farm structures. The speakers on the panel will be Carol Harding, Agricultural Associates; J. F. Schaffhausen, Johns-Manville Corp.; W. Everett Eakin, Libby-Owens-Ford Glass Co.; J. L. Strahan, Asphalt Roofing Industry Bureau; Wm. S. Birney, U.S. Steel Corp.; and G. W. Whitesides, Geo. W. Whitesides Co.

The rural electric program will open with a symposium on mechanical conveying and elevating of farm materials, with contributions by W. F. Keepers, Barn Equipment Assn.; M. B. Brookfield, Harry Ferguson, Inc.; and A. W. Clyde and A. S. Mowery, Pennsylvania State College. Other subjects on this program will include a paper on commercial hay-curing equipment for use of heat by J. B. Stere, C. A. McDade Co.; a farm crop drier by V. H. Baker, Virginia Polytechnic Institute, and the use of supplemental heat to dry baled hay by D. P. Brown, West Virginia University.

A general session on Wednesday forenoon, August 29, will open with a special student branch program, participants on which will be representatives of the Rutgers, Penn State, (Continued on page 444)

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Each year rats eat and despoil about \$2½ billion worth of foodstuffs—what it takes 265,000 farmers to produce. They kill millions of farm fowl. They carry human and livestock diseases. The control of these pests is one of today's leading agricultural problems.

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NEWS SECTION (Continued from page 442)

and Cornell Student Branches of ASAE. This will be followed by an address by Herbert Voorhees, president of the New Jersey Farm Bureau on the farmer's position in the mobilization program and an address by a representative of the agricultural machinery and implement division, National Production Authority, on the farm equipment supply situation. This will be the concluding session of the meeting.

Committee on Instrumentation and Controls

SUBSTANTIAL interest and progress in the work of the ASAE Committee on Instrumentation and Controls was noted in a meeting of the Committee at Houston, Tex., during the Annual Meeting of the Society in June.

In opening the Committee session Dr. W. H. Kliever, chairman, reviewed the three previously adopted objectives of the activity. He indicated that it is the purpose of the Committee to (1) find out who is doing work with various instruments and controls which would be of interest to others, (2) elicit information pertinent to the use of different functional instruments and controls, and (3) make the information available to people interested.

A start on the first and second of these objectives was noted in a progress report based on early returns in a survey of instrumentation in about 140 agricultural engineering research activities.

Ways of making the information available to interested agricultural engineers and others were suggested and discussed at the meeting. It was decided to rely on publication in *AGRICULTURAL ENGINEERING* as the primary means of putting the information on record in a readily available form. Plans were made to gather and edit material for an "Instrument News" column as a regular feature of the Journal, and to supplement this periodically with special articles on various phases of instrumentation.

In addition to Dr. Kliever, other Committee members present included Dr. Andrew Hustrulid, Dr. F. A. Brooks, S. H. Daines, and K. H. Norris. Thirteen other interested agricultural engineers attended the meeting.

Fletcher Elected Vice-President of Caterpillar

Leonard J. Fletcher, a past-president of the American Society of Agricultural Engineers, having filled that office in 1931-32, and also the 1941 recipient of the Cyrus Hall McCormick Gold Medal awarded by the Society, was recently elected vice-president of Caterpillar Tractor Co., Peoria, Ill. More recently director of training and community relations of the Company, Fletcher will now assist in the discharge of the constantly expanding duties that fall on the office of the Company president.

Leonard Fletcher is one of the early graduates from a professional agricultural engineering curriculum, having graduated from Iowa State College in 1915. Following graduation he was appointed instructor in agricultural engineering at the State College of Washington. From there he went to the University of California at Davis where for ten years he served first as an instructor and later as head of the agricultural engineering division. He joined the Caterpillar organization in 1927 as director of agricultural sales, and in 1937 he was named assistant general sales manager. He has served as director of training for the Company since 1941, and seven years ago his duties were increased to include the direction of the Company's community relations division.

Active in several organizations at local, state, and national levels, Mr. Fletcher is currently serving on the committee on education of the U.S. Chamber of Commerce and as an officer of the layman's department of the National Council of Churches. Besides his ASAE membership, he is also a member of the American Society of Mechanical Engineers, American Society for Engineering Education, and Public Relations Society of America.

Hawaii Section Program

TWO papers of particular interest featured the meeting of the Hawaii Section of the American Society of Agricultural Engineers held at the Hawaii Agricultural Experiment Station on June 8.

In a paper on plastic irrigation flumes Warren O. Gibson, agricultural engineer, Ewa Plantation Co., demonstrated the joining of flume sections with stove bolts and the insertion of plastic water outlets. The flume is of semi-circular section and is molded from phenolic resin sheets 1/16 in thick, 30 in wide, and 6 ft long. This material appears to be non-corroding, resistant to weathering, and to have adequate rigidity. It may be taken up and relaid without damage and with a fraction of the labor required for a concrete flume. A field-scale test has been installed by Ewa Plantation Co.

In discussing new developments in fertilizer application, Ernest H. Thomas of the Pacific Chemical and Fertilizer Co., pointed out that concentrated fertilizer cake badly in the humid sections of Hawaii and that considerable work is being done on fillers or additives to prevent this. Mr. Thomas also discussed distributors designed to cope with caked material, and application of anhydrous ammonia directly to the soil and in irrigation water.

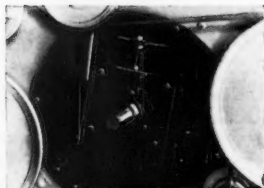
(Continued on page 446)

Power for threshing... not for friction

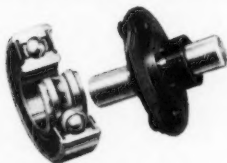


because this McCormick Thresher is Fafnir-equipped

This McCormick No. 64 Harvester-Thresher with a 6 ft. cutter bar features straight-through, balanced flow movement.



This close-up illustration shows Fafnir Ball Bearing Flangette and spacing adjustment between cylinder and concave.



Fafnir Flangette ball bearings with Mechan-Seals are used on cylinder, cylinder beater, feed beater, shaker shaft and fan shaft. Mechan-Seals positively exclude dust and dirt — prevent grease leakage. Fafnir radials with Plyo-Seals are used on other turning points. Plyo-Seals retain lubricant for life.

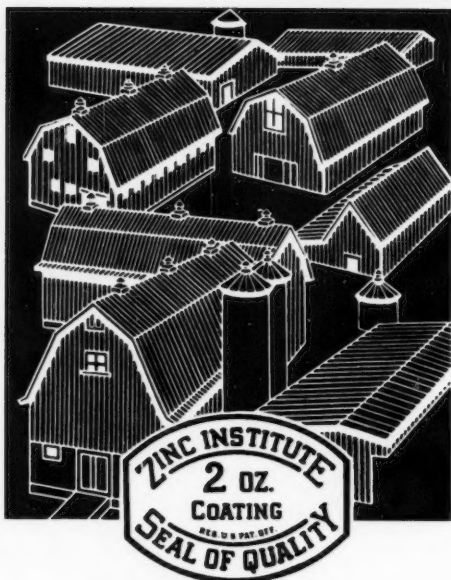
Power gets right down to business the moment it's applied on the McCormick No. 64 Harvest-Thresher. No fighting friction at the start or at any time, because the Thresher's high speed shafts are installed on Fafnir Ball Bearings with lubricant sealed in. The results . . . low cost operation from every angle.

"The 64 Thresher continues to rotate several minutes after the power is shut off," says one enthusiastic owner. That's a tribute to its balanced designing and its ball bearings, too . . . a reason why the machine is so easy to haul.

Like other leading manufacturers of farm equipment, International Harvester has made good use of Fafnir Bearings over the years. Twelve of them are used on the McCormick No. 64 Harvester-Thresher. Ten are Flangettes with the famous Fafnir Wide Inner Ring Bearings and self-locking collars. There's more than just good bearings involved however . . . the Fafnir attitude and aptitude . . . a way of looking at ball bearings from the designers' viewpoint and an aptitude gained from over 40 years' specialization in ball bearings. The Fafnir Bearing Company, New Britain, Conn.



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NEWS SECTION (Continued from page 444)

The meeting was attended by 30 ASAE members and guests of whom a number had flown from the other islands. The Section accepted the resignations of Rene Guillou as chairman and Roy T. Tribble as secretary. Mr. Guillou is going to an agricultural college and experiment station being established in Thailand under the United States foreign aid program, and Mr. Tribble has been called to active duty in the Navy. Mr. Guillou gave out the interesting information that ASAE membership in Hawaii now exceeds that in sixteen of the states on the U.S. mainland.

New ASAE Section Authorized

ON PETITION from a group of ASAE members, the Council of the American Society of Agricultural Engineers at its meeting in Houston, Texas, in June, authorized the organization of a new regional section of the Society, to include the area within Colorado, New Mexico, Utah, Wyoming, southeastern Idaho and eastern Nevada. At the time members in this area were canvassed by the sponsor group, regarding the formation of such a section, they were asked to indicate preference as to the name for the new section. By an indicated preference of more than two to one for the name "Rocky Mountain Section," the Council approved this as the official name of the new section.

Discussion favoring the establishing this new section had been in progress among interested members for over a year.

Agricultural Engineers Needed Abroad

ARECENT reminder from the Office of Personnel, U.S. Department of Agriculture, indicates that they are still looking for agricultural engineers to represent the United States in various countries concerned in the technical cooperation program. That office is preparing a roster of qualified and available men for use by the Departments of Agriculture, Army, Commerce, Interior, Labor, and State; Economic Cooperation Administration; Federal Security Agency; and United Nations organizations in making assignments for specific technical-aid activities.

Areas of assignment for which applicants may indicate preference include 19 countries in the Western Hemisphere, 12 in the Middle East, and 13 in the Far East.

Branches of specialization in agricultural engineering particularly desired are hydrology, irrigation, rural electrification and farm machinery. There is also a demand for related specialists in land use, soil conservation, and soils science.

U.S. citizens with technical training and experience in either research or extension, preferably between the ages of 30 and 60, with leadership ability and maturity of judgment are desired. No civil service examination is required but the grade and salary scale corresponds generally to the civil service range from GS-11 to GS-15, inclusive (\$5,430 to \$10,330). It is expected that most assignments will run from 2 to 5 years, but some shorter and longer assignments may also be available.

Interested persons who believe themselves qualified for any of these assignments, may write to the U.S. Department of Agriculture, Office of Personnel, Washington 25, D.C.

PERSONALS OF ASAE MEMBERS

J. W. Autry, who has been associate professor of agricultural engineering at Tarleton State College, Stephenville, Tex., since 1947, will, on September 1st, become director of the division of agriculture at that institution. A native of Stephenville, Mr. Autry received his BSAE degree from A. & M. College of Texas in 1942 and his MSAE degree from Oklahoma A. & M. College in 1950.

William M. Cade has recently joined the advanced design section, engineering department, East Moline Works, International Harvester Co., East Moline, Ill. He was previously connected with the engineering department of the French & Hecht Div., Kelsey-Hayes Wheel Co. at Davenport, Iowa.

W. M. Bruce, W. E. Garner, J. W. Simons, and L. L. Smith have collaborated in preparing a bulletin on "Planning Grain Elevators for the Southeast," recently published by the University of Georgia.

B. J. Butler, formerly instructor in the agricultural engineering department at the University of Missouri, has accepted a position in the U.S. Department of Agriculture, and has been assigned to research work at the Toledo, Ohio, laboratory of the Department.

Robert L. Green will be on leave the next two years as instructor in agricultural engineering at Louisiana State University, to accept appointment as agricultural engineer with the Economic Cooperation Administration. He will be stationed at Djakarta (formerly Batavia) in Indonesia. It is expected that his work in Indonesia will include all phases of agricultural engineering but deal primarily with drainage and irrigation.

(Continued on page 448)

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Morse Double Pitch Chains are made with the same exacting precision as are Morse Standard Roller Chains. They give you the same strength and positive power transmission with less weight, less cost. They save space, operate efficiently on long or short centers and maintain accuracy between two parallel strands.

Morse Double Pitch Roller Chain is available in the Power Transmission series (contour-design side plates) and the Conveyor series (straight, heavy-duty side plates) made to American Standards from 1" pitch to 2½" pitch. Conveyor series is stocked with both standard and large rollers. Standard attachments available.

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Power
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New Double Pitch Roller Chain Catalog



Write today for Catalog C 52-50, which gives you complete information on Morse Double Pitch Roller Chain (Conveyor Series and Power Transmission Series) and Sprockets. Lists standard attachments, gives helpful data on selection.



Conveyor
Series

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Transmission
Series

MORSE

MECHANICAL
POWER TRANSMISSION
PRODUCTS



PERSONALS OF ASAE MEMBERS

(Continued from page 446)

Wilbur L. Griebeler has resigned as assistant professor of agricultural engineering, Oregon State College, to accept appointment as western representative for the field promotion department of the Douglas Fir Plywood Assn., with headquarters at 221 Manor Dr., South San Francisco, Calif. His territory will include California, Arizona, and Nevada.

Jose Manuel Guzman was recently re-elected president of the Costa Rican Society of Agricultural Engineers for 1951-52.

G. E. Henderson, coordinator, Southern Association of Agricultural Engineering and Vocational Agricultural Educators, has in publication a new 30-page 8½ x 11-inch bulletin prepared as a text and reference for teaching non-technical high school students the fundamentals of "Planning the Farm Home Wiring System."

W. Kalbfleisch, agricultural engineer, Experiment Farm Service, Dominion Department of Agriculture, is author of Publication 746 of that agency, "Mower Repairs and Adjustments," reprinted in January of this year. He is also joint author with J. W. White, assistant agricultural engineer, of Publication 839, "Principles of Barn Ventilation."

A. H. Keller, until recently chief engineer of the East Moline Wks., International Harvester Co., East Moline, Ill., has been appointed manager of engineering for the International Harvester Co. in France. His assignment will cover all types of engineering in the Company's three plants in France, and he will be located at the general office in Paris.

William H. Knight and **J. W. Martin** are joint authors of Idaho Farm Electrification Leaflet No. 14, on "Electric Farm Welders."

Dalton G. Miller and **Philip W. Manson**, division of agricultural engineering, University of Minnesota, are authors of "Long-Time Tests of Concretes and Mortars Exposed to Sulfate Waters," now in publication as Technical Bulletin 194 of the Minnesota Agricultural Experiment Station.

Albert T. Peterson was recently appointed to the engineering staff of the United Water Conservation District, Ventura County, California, to work with it on hydrologic investigations and the design and construction of surface storage reservoirs and related works.

Harold S. Secher has been promoted from assistant chief engineer to the position of chief engineer of product engineering at the East Moline Wks. of International Harvester Co., East Moline, Ill. This change of position also involves the advancement of **R. Barkstrom** to assistant chief engineer of product engineering at the East Moline Wks.

W. H. Sheldon, **D. E. Wiant** and **R. W. Kleis** are joint authors with S. T. Dexter of "Barn Hay Driers in Michigan," Circular Bulletin 219 of Michigan State College.

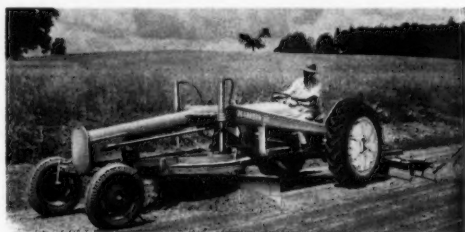
Richard O. Trapp recently resigned from the service department of the Dearborn Motors Corp. to accept a position with Milton E. Disser and Associates, of Detroit, eastern representatives of Richmond, Inc., and Tubing Seal Cap, Inc.

John H. Zich has just been made manager of the new product investigation department of Dearborn Motors Corp. This is an advancement from the position of assistant tractor and implement sales manager which he previously held. Prior to joining the Dearborn Motors in 1947, Mr. Zich was assistant service manager for Harry Ferguson, Inc., and earlier a project engineer for Allis-Chalmers Mfg. Co.

NEWS FROM ADVERTISERS

New Products and Literature Announced by
AGRICULTURAL ENGINEERING ADVERTISERS

Dearborn Road Maintainer. Dearborn Motors Corp., Birmingham, Mich., announces a new road maintainer, which provides many features found in heavy motor graders. The 8-ft blade is operated by a separate hydraulic mechanism powered directly by the engine crankshaft, freeing the tractor hydraulic mechanism to operate accessory equipment. The blade can be operated in three pitch positions and nine angle positions and can be lifted 9½ in above the ground, all through positive hand



The Dearborn road maintainer

levers or hydraulic controls convenient to the operator. The blade is equipped with a replaceable cutting edge and end bits. Maximum blade pressure is 3,500 lb with the blade at a 90-deg angle to the frame. Featuring an all-welded, heavy, tubular steel frame, complete with the Ford Tractor it weighs 6,900 lb, is 18 ft in length and 6 ft 8 in wide. The entire maintainer attachment can be removed from the tractor in approximately 3 hr and the Dearborn side-mounted mower installed on the tractor for highway mowing.

Knoedler Safety Reverse Gear for Corn Pickers. Knoedler Manufacturing, Inc., Streator, Ill., has ready for the market a new reversing gear for the snapping and husking rolls of corn pickers. It reduces the hazard and time loss commonly involved in unclogging these rolls, by enabling the operator to do it from the tractor seat. Shifting a lever reverses the rolls and gathering chains, unwinding and releasing the material causing the clogging. A special ratchet drive prevents reversing the elevator mechanism. The device has been field-tested under a wide variety of conditions during the past several seasons. Models have been made available to fit Oliver and Case two-row pull-type pickers from 1937 to date; all New Idea Series 6 two-row, pull-type pickers; and all New Idea Series 7 and 8 one-row, pull-type pickers. They may be installed without defacing these pickers in any way. Indicated prices are \$104 to \$115 installed, depending on the model required.

American THE COMPLETE CROP DRYING LINE

American Crop Drying offers you the only complete line of drying equipment on the market—heat drying, air drying, bins and moisture testing equipment. In addition, All-Crop

Dryer capacities are GUARANTEED. You can recommend this equipment to the farmer knowing that it will fully handle his crop drying needs. Write today for details.



MODEL 18
All-Crop Dryer
Underwriter's
Labs Approved

For the average sized farm. Automatic safety and temperature controls. 780,000 BTU output per hour, 11,200 cu. ft. air per minute. Equipped with vane-axial fan and single furnace. May be powered by 3, 5, or 7½ h.p. electric motor or gasoline engine. GUARANTEED capacity.



MODEL 25
All-Crop Dryer

For the larger farm. Dries all crops. Equipped with vane-axial fan and double furnace. BTU output, up to 1,560,000 per hour. Air output up to 20,050 CFM at 5 H.P. Automatic safety and temperature controls. Powered by electric motor, gasoline engine or tractor. Capacity GUARANTEED.



MODEL 606
Vane-Axial Fan
Only portable
complete crop
curing Fan-Unit
on the market
today. Vane-axial

design assures more air delivery for those hard to cure crops. Air output, 20,050 CFM using 5 H.P. electric motor. Motor and belts shielded for protection and safety.



MODEL M-20
ALL-CROP
MOISTURE TESTER

Saves guess work. Electric . . . simple to use . . . gives accurate direct reading of moisture percentage. Farm tested, and proved.

American—the oldest exclusive manufacturer of portable farm crop drying equipment

AMERICAN CROP DRYING EQUIPMENT CO.
CRYSTAL LAKE, ILLINOIS

what's **YOUR** headache...



BRUSH

An area to be cleared before a diversion ditch can be cut... bulldozer and grader blade provide the one-two punch that gets the job done easily and quickly.



ROCK

On an A-W Power Grader the bulldozer becomes a rough, tough tool... extra sturdy to match the extra power of ALL-WHEEL DRIVE, and fully up to this job of handling heavy rock.



SAND ?

Live, climbing power at both ends of the machine keeps it bulldozing steadily through sand where an ordinary grader would find it difficult to travel, let alone work.



TREES ?

First, the grader blade with its deep-plowing ability is socked into the ground to undercut the tree roots; then the bulldozer, backed by the superpower of ALL-WHEEL DRIVE, finishes the job.

there's a
JOB
to be done

Yes... Lots of things to Push Around...

and one *very good* way to do it is with an A-W Power Grader with its exclusive All-Wheel Drive and All-Wheel Steer for maximum traction and maneuverability. The Bulldozer is an essential for many jobs... a time and money-saver for dozens of others.

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Pressure

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VISUAL WARNING SYSTEM for Gas and Diesel Engines

This unique signal system gives a virtually foolproof warning whenever there's engine trouble... low oil or air brake pressure, high water or oil temperature, or generator failure. And it points out the trouble before expensive damage is caused.

Under normal conditions, a pilot light glows steadily. But when something goes wrong, it flashes brilliantly. It even indicates when the system itself is not operating. TELLITE is available with one flasher, or individual flashers connected to each point of contact to tell just where the trouble is.

This inexpensive trouble shooter is ideal for trucks, buses, tractors and industrial engines. Write for complete information. ROCHESTER MANUFACTURING CO., INC., 99 Rockwood St., Rochester 10, N.Y.



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RESEARCH NOTES

ASAE members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest, whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mo.

USDA Agricultural Engineering Research

Engineers Face Ginning Problem. C. A. Bennett, principal engineer, USDA Cotton Ginning Laboratory, Stoneville, Miss., says that because mechanically harvested cotton contains more trash than hand-picked cotton, ginners are required to do additional cleaning. This results in a tendency to overdry the cotton in order to make it easier to clean, and to offset possible damage from overdrying, moisture-restoration methods must be used. The big problem is to find means for rapid control of uniform moisture content in seed cotton and cotton fiber during the ginning processes. Both the correct moisture content of seed cotton and fibers and how to speed up the moisture absorption by the cotton at a much faster than normal rate must be known. The time element has been a barrier in first trying to dry the cotton for best cleaning, and then quickly restoring adequate moisture to it for best ginning, lint cleaning, and pressing. USDA engineers recognize the problem and are concentrating upon it in both the rain-grown and irrigated-cotton-producing areas.

Self-propelled Canning Corn Sprayer. Complete construction details of a high-clearance sprayer that does an excellent job controlling European corn borers and corn ear worms in canning corn are available in Information Series No. 103. Single copies of this publication can be obtained free of charge from the Divisions of Agricultural Engineering, Agricultural Research Center, Beltsville, Md. Developed and tested by D. T. Black, USDA engineer, this sprayer is especially adapted to the needs of the canning corn industry. The plans included in I.S. 103 are for a sprayer suitable either for the rough hilly terrain of Maryland corn fields, or the more level areas of other corn-growing states.

Adequate Farm Storage Important. Ready farm storage to adequately handle this year's harvest is as important in reaching record-breaking food and fiber goals as any other phase of crop production, according to Wallace Ashby, head, USDA Division of Farm Buildings and Rural Housing. If production is as high as is hoped for, commercial and cooperative storage is bound to be jammed, transportation facilities will be overburdened, and farmers will, in many cases, be forced to rely more than usual on storage of their own.

How badly much of the nation's present farm storage needs repair is indicated in the results of a recent survey of 7,000 Georgia farms, probably typical of the Southeast. This study showed that 74 per cent of the storages could not be effectively fumigated for insect control, 96 per cent were not rodentproof, and less than half of the storages offered good protection from the weather.

USDA engineers likewise examined many such buildings used for wheat and shelled corn storage in six midwestern states and determined the need of good foundations, floors, walls, and roofs, and of well-constructed doors, ventilator and roof-hatch openings in protecting grain from damage. Even a small leak around a metal roof bolt, unprotected by a lead or neoprene washer, led to the spoilage of two or three bushels of grain.

Mechanized Cotton Thinning. Recent laboratory studies by the USDA and Oklahoma agricultural engineers indicates that modifications in present-day cotton planters will result in precise planting of acid-delinted cotton seed. Undesirable cotton seed scatter, the engineers learned, are due to three main causes: (1) The manner in which the seed was gathered and dispersed from the cells in the planter plates; (2) the shape and location of the tubes that carry the cotton seed from the cells to the ground, and (3) the distance the seed drops through the tube to the ground.

Using a cotton-planting mechanism, a hopper that could be adjusted in height, and a greased board which held the seed where it dropped, it was found that use in the planter hopper of slowly revolving, hill-drop plates with short, broad cells, helped reduce scatter considerably. The best results were obtained with plates turning at speeds below 30 fpm and with cells capable of holding three of four seeds that were simultaneously knocked from the cell into the seed tube.

Different planting rates were accomplished by changing the number of cells in the plate, rather than by altering the plate speed. Four to 16 cells per plate were used without any important effect on scattering of seed.

The seed tube was improved by making it wide enough so the cotton seeds more nearly followed what would be their normal path from the cell to the ground. This reduced the buffeting the seeds normally got from the sides of the seed tubes on conventional planters, and thus eliminated a big cause of scattering.

Ground scatter was sharply reduced by keeping the height of fall under 18 in. Some success was had with planters that dropped seed directly behind the furrow opener. This offered a barrier to excessive seed scatter ahead of the seed tube.

The best results were obtained when ground speed and plate speed were maintained at a ratio of near 8 to 1. With plate speeds below 30 fpm, dispersal of cotton seed was less than 1½ in. in diameter at planter speeds of about 3 mph.

Refrigeration Research Survey. A survey of 160 farm walk-in-type refrigerator-freezers to determine their advantages and shortcomings is guiding USDA research workers in developing a more useful and efficient farm refrigeration unit. The bulk of the refrigerator-freezers inspected were farm-built, two-temperature units constructed generally from state agricultural experiment station plans.

USDA workers believe that by correcting the faults found in the farm units and incorporating research-developed improvements, they can provide construction methods and plans that will bring satisfactory refrigeration within the reach of more and more farm families.

Research efforts are directed toward developing a unit not only adequate to care for the normal food-storage needs of the farm family, but to provide storage room for perishable farm products that go to market infrequently. Construction features are being incorporated that make it adaptable to sectional construction so that it can be built locally right on the farm if desired, and installed in locations convenient to the kitchen or normal work center.

The experimental walk-in, two-temperature refrigerator with which they are working out their problems contains two areas—a walk-in chill room kept at 37° F and inside that, or next to it, a 0° F freezer. The chill room, although it can be modified to fit different farming enterprises and family needs, will generally contain about 250 to 300 cu ft of space. When final plans are drawn, the entire unit will probably measure about 8 ft by 10 ft by 8 ft high.

Field Grading Apples. Grading apples in Michigan orchards with an experimental field grader, reduced fruit (Continued on page 452)

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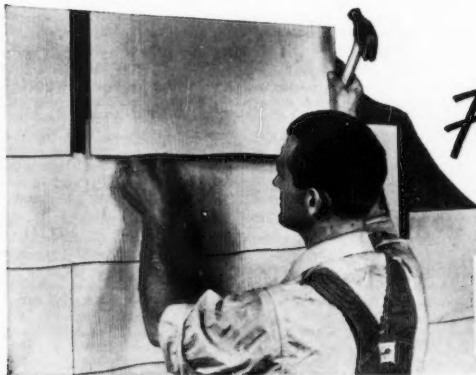
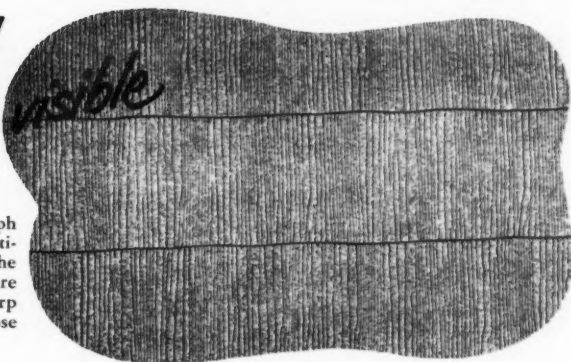


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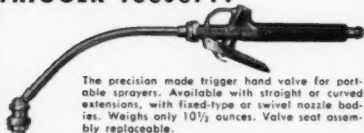
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RESEARCH NOTES

(Continued from page 450)

bruising and cut grading costs, report USDA research engineers, in their work with horticulturists of the Michigan Agricultural Experiment Station. Orchard-graded apples go directly into containers in which they move to market or to cold storage. This eliminates several steps in the grading and packing process, and reduces bruising that normally accompanies these operations. Also, growers who store orchard-run fruit ordinarily pay cartage and storage charges on a large percentage of the crop that later goes to processing outlets. By grading in the field the small and defective fruit can be eliminated and the growers pay storage charges on number one fruit only.

Manufacturers of apple-grading equipment are adding a field-grading machine to their regular lines of equipment offered to farmers. A complete report of this research is available in Michigan Agricultural Experiment Station Quarterly Bulletin, reprint 33-41, titled "Grading Apples in the Orchard".

NEW BULLETINS

A Graphic Solution of Airplane Sprayer Problems, by James E. Garton. Miscellaneous Publication No. MP-20 (May, 1951) Oklahoma Agricultural Experiment Station (Stillwater). This solution is worked out along the same lines as the earlier one for field sprayers, with valves throughout appropriate to an indicated ground speed range from 30 to 120 mph.

An Investigation of the Application of Statistical Quality Control to Dairy Manufacturing, by A. V. Moore and J. P. CoVan. Texas Engineering Experiment Station (College Station) Research Report No. 23 (March, 1951). This is of special interest as a cooperative project of the Texas agricultural and engineering experiment stations, and as an attempt to utilize in the farm-product processing field certain principles and quality-control methods developed and of proven value in somewhat analogous metal-processing operations. It is pointed out that statistical quality control involves some relatively fixed costs which enable it to show greatest advantage in large-scale operations.

Determining Water Requirements in Irrigated Areas from Climatological and Irrigation Data, by Harry F. Blaney and Wayne D. Criddle. U.S. Department of Agriculture, Soil Conservation Service technical publication SCS-TP-96 (Washington 25, D.C.). This is a complete revision of earlier reports with substantially the same title published in 1945 and revised in 1947. It deals with the influence of various factors on water use, irrigation efficiencies, method of estimating water requirements, and application of the method to specific areas.

Engineering Soil Survey of New Jersey, by Franklyn C. Rogers. Engineering Research Bulletin No. 15, Rutgers University (New Brunswick). This is the first of a projected series of 22 reports dealing with soil as a material to be reckoned with in engineering. It introduces the series and presents material applicable to the state as a whole and the overall project. Subsequent reports will each be devoted to information on an individual county. The project is sponsored jointly by the Rutgers University Bureau of Engineering Research and the New Jersey State Highway Department in cooperation with the U.S. Bureau of Public Roads. Chapters cover climate and physiography, geology, soils, soil mapping technique, airphoto mapping method, soil testing procedures, and explanation of soil identification.

A Study of Bituminous Soil Stabilization by Methods of Physical Chemistry, by A. C. Andrews and G. G. Noble. Kansas Engineering Experiment Station (Manhattan) Bulletin No. 63 (August, 1950). Reports on work to improve laboratory tests for evaluation of properties of some of the materials used, and to broaden the range of soil types subject to practicable bituminous stabilization. Results are indicated as inconclusive but of value to further study along these lines.

First Proceedings of the Engineering Section, Tobacco Workers' Conference, by V. H. Baker, secretary, Gainesville, Fla., June, 1950. This report contains papers and abstracts of papers presented at the meeting on curing bright-leaf tobacco, generating heat for curing bright-leaf tobacco, curing burley tobacco, shade tobacco curing research in Georgia, fumigation equipment for the control of rootknot, equipment for insect and disease control, and cultivation for the removal of weeds. Reports were also given on research activities in production and harvesting by Connecticut, Massachusetts, Florida, Georgia, Kentucky, Maryland, North Carolina, South Carolina, and Virginia.

Planning the Farm Home Wiring System, by G. E. Henderson and C. E. Turner. Southern Association of Agricultural and Vocational Agricultural Educators (University of Georgia, Athens). This is a brief, bulletin-style, special subject text and reference for instruction in the subject to non-technical students at high school level. It covers determining load; kind, number, and location of outlets and switches; branch-circuit requirements; selecting the proper size of service entrance, and contracting for the wiring job. It is specifically indicated that this publication does not attempt to cover instructions for installation of a wiring system.



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that requires our combined efforts.

If we're to save our dwindling supply of rich topsoil, we must work together. Conservation demands teamwork. Saving our soil is a job for all of us — for we who design and build farm machinery . . . for the farmers who use it . . . and for you, the agricultural specialists who work with and guide America's 6 million farmers.

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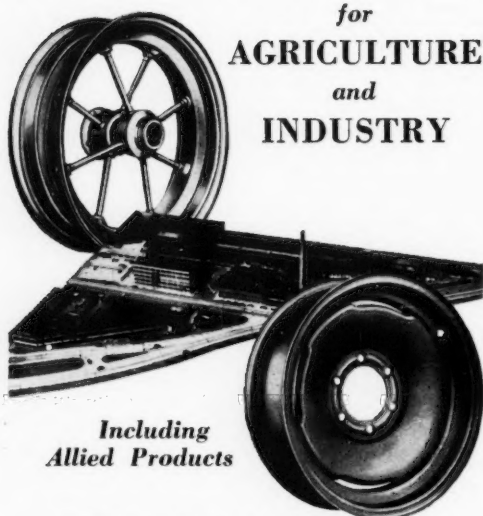
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Measuring Water-Application Efficiency

(Continued from page 433)

7 The inclusion of the consumptive-use correction factor accounts for a positive volume of water which has been neglected in past studies. The net effect, then, is always a higher efficiency than is computed if the consumptive-use factor is neglected.

8 Results of this study can be applied to other work to approximate the effect of the consumptive-use correction factor, but *only if* the values of the consumptive-use rates are about the same for the crops in both studies.

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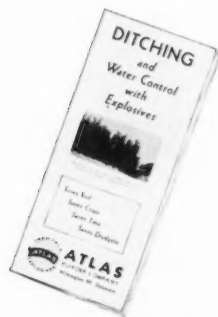
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Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. The Society does not investigate or guarantee the representations made by parties listed. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request. "Agricultural Engineer" as used in these listings, is not intended to imply any specific level of proficiency, or registration, or license as a professional engineer.

NOTE: In this bulletin the following listings still current and previously reported are not repeated in detail; for further information see the issue of AGRICULTURAL ENGINEERING indicated.

POSITIONS OPEN: NOVEMBER—O-102-510. DECEMBER—O-113-514. 1951—APRIL—O-226-525. JULY—O-299-527, 300-528, 301-529, 304-530, 305-531.

POSITIONS WANTED: NOVEMBER—W-99-18. 1951—JANUARY—W-140-25, 145-27. FEBRUARY—W-156-31, 164-35. MARCH—W-120-37, 172-39, 185-42. APRIL—W-196-44, 202-46, 227-47, 212-48, 219-51. MAY—W-252-53, 253-54, 276-56, 277-57. JUNE—W-264-58, 260-59, 232-60, 261-62, 280-63, 263-65. JULY—W-205-66, 255-67, 289-68.

NEW POSITIONS OPEN

AGRICULTURAL ENGINEER (instructor) to teach courses in farm shop, farm structures, and farm machinery to students in agricultural engineering and agriculture, in a land grant college in the Southeast. MS deg in agricultural engineering preferred. Man with BS deg and one or two years teaching experience will also be considered. Good references required. Summer term teaching in addition to regular school year. Approximately 8 weeks vacation per year including student holidays and period between semesters. Good opportunity for advancement. Age preference, none. Salary \$4200 on 12-mo basis. O-282-532

AGRICULTURAL ENGINEERS (indefinite number of positions to be filled) for educational and administrative work in connection with program of technical aid to other countries. Location foreign. Preference may be indicated for service in any of a number of countries in the western hemisphere, the Middle East and Far East. BS deg in agricultural engineering or equivalent. Minimum 3 yr experience in field, preferably in extension or research. Good health, ability to meet and associate with foreign peoples, and an abundance of common sense required. Minimum 2-yr contract. Transportation to and from country, including family and household goods, to be paid by employer. (Employer may be any of several federal agencies or the U.N.) Opportunity for advancement to GS-13. Age 30-55. Salary GS-11 (\$5430) to GS-13 (\$7830), plus differentials and allowances according to the situation. O-320-533

NEW POSITIONS WANTED

DESIGN, development, extension, teaching or writing in farm structures or soil and water field, with college or industry, preferably in Southeast. BS deg in agricultural engineering. 1950. University of Georgia. MS deg in agricultural engineering expected August, 1951. University of Missouri. Farm background. One year graduate research assistant in climatic laboratory. War noncommissioned service in Army Air Force 2½ yr, including one year as aerial gunnery instructor. Single. Age 25. No disability. Available Aug. 15. Salary open. W-310-69

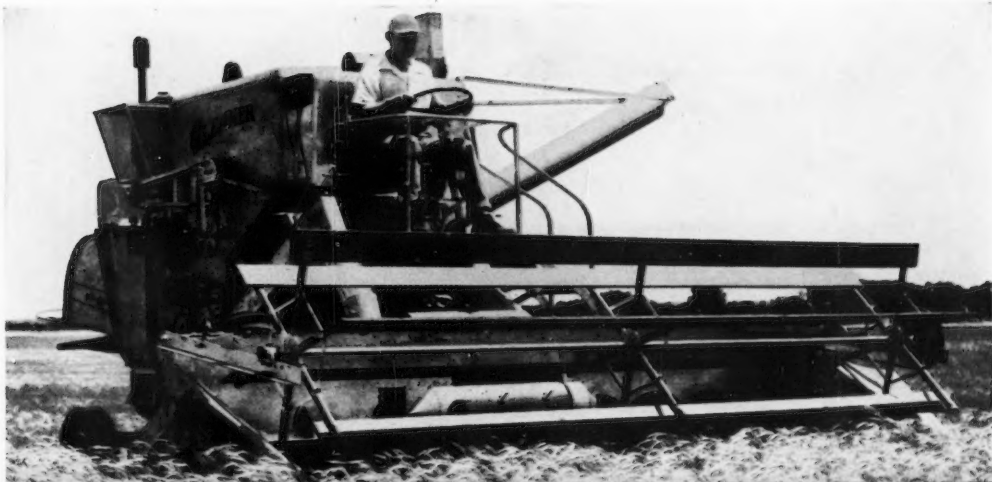
DESIGN, development or research in the soil and water field, in industry or public service, anywhere in U.S.A. BS deg in agricultural engineering. 1948. Clemson Agricultural College. MS deg in agricultural engineering expected September 1951. Virginia Polytechnic Institute. Farm background. Two years teaching, research and extension in agricultural engineering in a university in the Northeast. War noncommissioned service in Infantry over 2 yr. Single. Age 26. No disability. Available October, 1951. Salary open. W-315-70

EXTENSION, teaching, sales, service, or management, in power and machinery, soil and water or product processing field in public service, with manufacturer, or in farming operation, anywhere in U.S.A. BS deg in agriculture expected February 1952. University of Florida. Major in agricultural engineering, minor in agricultural education. Farm background, including ownership and operation of a farm, dairy, and retail dairy store for 13 yr. War enlisted service, 9 mo. Married. Age 33. No disability. Available Feb. 10, 1952. Salary \$4200 min. W-292-71

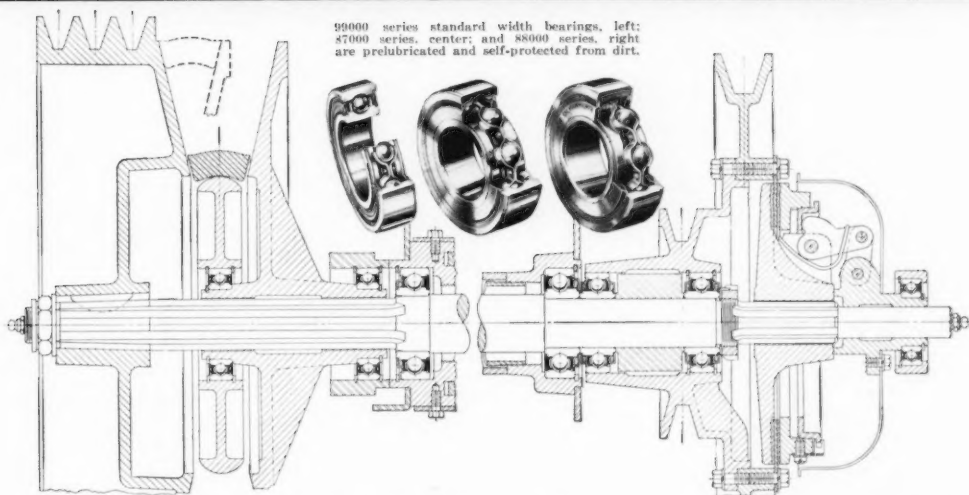
NEW BOOKS

HEATING, VENTILATING, AND AIR CONDITIONING GUIDE, 1951 (29th edition). Cloth xxiv+1456 pages, 6 x 9 inches. Illustrated and indexed. American Society of Heating and Ventilating Engineers (51 Madison Ave., New York 10, N. Y.) \$7.50.

Technical and manufacturers catalog data sections. In the technical data section, subsection headings and chapter groupings are the same as for last year's edition. Based on new information and practice, changes have been made in the chapters on abbreviations and symbols, thermodynamics, fluid flow, heat transfer, air conditioning in the prevention and treatment of disease, heat transmission coefficients of building materials, heating load, cooling load, automatic fuel burning equipment, chimneys and draft calculations, forced warm air systems, hot water heating systems, panel heating, air duct design, fans, refrigeration, automatic control, motors and motor control, owning and operating costs, water services, instruments and measurements, and codes and standards.



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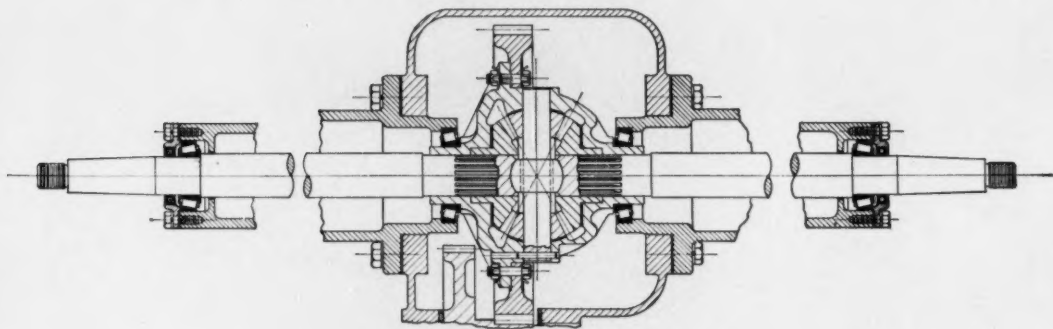
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